

FEDERAL REPUBLIC OF NIGERIA

**Annual Report of the
Federal Institute of Industrial
Research, Oshodi
1972-73**

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1979

FEDERAL MINISTRY OF INFORMATION
PRINTING DIVISION, LAGOS

**ANNUAL REPORT OF THE
FEDERAL INSTITUTE OF INDUSTRIAL RESEARCH**

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FOREWORD

Although Nigeria is basically well endowed with agricultural as well as mineral resources, it is the policy of the Government to diversify the national economy by encouraging the establishment of industries, particularly those based on the processing of the country's raw materials. The realisation of this policy led in 1955 to the establishment of the Federal Industrial Research.

The Institute, situated eight miles from Lagos on the Lagos-Abeokuta road has developed steadily since its establishment and now comprises one old block and four new buildings in its 25-acre premises.

The aim of the Institute is to help anyone to set up as quickly as possible new industries based on any Nigeria raw material. With this in view, it investigates the suitability of Nigeria's raw materials for use in proved industrial processes and modifies these processes to suit local conditions. Another subsidiary aim of the Institute is to give technical assistance to existing industries by the provision of Laboratory facilities for the analysis of samples of their products and seeking solutions to their basic technical problems. The services of the Institute are at the disposal of any government, private company or individual on terms to be agreed upon. Advice is given free.

Research programmes are prepared every three years and reviewed annually. The criteria used for the choice of in-house research projects are :

- (1) import substitution ;
- (2) primary processing of raw materials for local industries ;
- (3) development of native technology.

Contract research is accepted at any time subject to the limitations set by the expertise and infrastructural facilities available in the Institute.

BOARD OF MANAGEMENT OF THE REVOLVING FUND 1972-73

MR A. S. N. EGBO—Chairman,
Deputy Permanent Secretary,
Federal Ministry of Industries.

MR J. C. OBI,
Principal Assistant Secretary,
Federal Ministry of Finance.

DR C. P. EZEIFE—Director,
Central Planning Office,
Federal Ministry of Economic Development
and Reconstruction.

MR KOLA DAISI,
Secretary,
Nigerian Chamber of Commerce and Industry

DR I. A. AKINRELE—Director,
Federal Institute of Industrial Research,
Oshodi.

MR M. O. TANIMOWO—Secretary/Treasurer,
Cost Accountant,
Federal Institute of Industrial Research,
Oshodi.

SENIOR STAFF

(AS AT 31ST MARCH, 1973)

Director	.. .. .	I. A. Akinrele, M.A. (Cantab.), D.I.C., Ph.D. (Ibad.), M.I. Biol., M.I. Food Tech.
Deputy Director	.. .. .	*G. O. Chigbo, M.Sc., Ph.D. (Sheffield), A.R.I.C., A.I. Ceram.
Administrative Secretary		
Principal Research Officers (5)	..	M. I. O. Ero, M.Sc. (Stanford), Ph.D. (Purdue) J. A. Dina, M.A. (Stanford), B.Sc. (Michigan) O. A. Koleoso, M.Sc., Ph.D. (Sask.), F.C.S., M.C.I.C. 2 Vacancies
Senior Research Officers (12)	..	A. K. Fasina, Ph.D. (Ibad.), Dip. Anal. Chem. (Ibad.), F.C.S., A.R.I.C. *L. L. Akerele, Dip. Tech, Tex. (Bolton), A.T.I. M. V. Rajagopal, B.Sc., Ph.D. *F. O. Olatunji, B.Sc., Hons. (Ibad.), M.Sc. (Lond.) Grad. I. Chem. E. *E. O. Ofulue, B.Sc. Hons., Dr, rer, nat. 7 Vacancies

SENIOR STAFF—continued

Research Officers, Grade I (12)	..	..	..	..	A. B. Oniwinde, M.Sc., Ph.D. (S'-Oton) R. O. Okotore, M.Sc., Ph.D. (Dal.). S. C. O. Onyekwelu, M.Sc., A.I.Ch. E. S. Ahonkhai, B.Sc., Ph.D. (Ibad.) +E. O. Umeh, B.Sc., M.Sc., Ph.D. +A. O. Olunloyo, *O. A. Kuboye (Mrs) B.Sc. Hons. (Lagos) *T. O. A. Akinola, A.I.E.E. *B. L. Ariyo (Mrs), B.Sc. Hons. (Ibad.), Dip. Lib. (Ibad.) 2 Vacancies
Research Officers, Grade II (16)	..	..	..	..	T. A. B. Faleye, M.Sc. (Moscow) H. M. Joseph (Miss), B.Sc. (Ife) F. A. O. Osinowo, B.Sc., M.Sc. (Leeds) O. S. Imoukhuede, B.Sc. (Lagos) D. D. Nwaohiri, B.Sc. (Nsukka) O. O. Akinnowo, B.Sc., M.Sc. A. C. Asoh, M.Sc. *A. O. Omofade, H.N.C. O. A. Gibson-Roberts, B.Sc. (Ife) C. T. Onuoha, M.Sc., M.A.C.S., M.A.I.C.E. F. N. Igwilo, B.Sc. A. Y. O. Falua, B.Sc., M.A. J. C. Okere, B.Sc. (Nsukka) J. O. Alokwe, Dip. Ing. (Techn.) 1 Vacant
Engineer	..	..	..	..	Vacant
Librarian	..	..	..	..	R. O. Sodipe, A.L.A.
Senior Technical Officer	..	..	..	..	K. Oniya, Dip. Ceram, L.I. Ceram., A.M.B.I.M.
Higher Technical Officers (2)	..	..	..	..	*O. Gbadamosi, (Mrs), A.I.S.T. 1 Vacant
Technical Officers (8)	..	..	..	..	L. I. Ogueri, B.Sc. A. B. Meadows, H.N.D. *M. U. Ekpo, H.N.D. 1 Vacant
Accountant	..	..	..	..	M. O. Tanimowo, A.C.W.A., A.C.C.A.
Executive Officer (Administrative)	..	..	..	..	G. S. A. Animashaun
Executive Officer (Accounts)	..	..	..	..	Vacant
Stores Officer	..	..	..	..	M. O. Oni
Higher Workshop Supervisor	..	..	..	..	J. A. Peters
Confidential Secretary	..	..	..	..	R. A. Omali (Mrs)

PART ONE

INTRODUCTION

With the establishment of the Industrial Research Council of Nigeria in February, 1972, the Federal Military Government thus created a framework for the organisation and co-ordination of industrial research throughout the country. The Council was empowered to seek the transfer of existing industrial research institutes to management boards created under its supervision. With this background, it was considered appropriate not to reconstitute the Governing Council of this Institute when its current term expired during the year. The hope was generally held that the Industrial Research Council would be able to establish a management Board for this Institute soon after. However, this could not be realised because of the technicalities of creating the necessary legal framework for the transfer of the Institute to the council. Nevertheless, a cordial and close relationship existed throughout the year between the Institute and the Council and, as a matter of fact, the Institute offered facilities for accommodation of the Secretariat of the Industrial Research Council.

2. The research programme of the Institute continued in the line of projects instituted in the previous years. The progress reports on each of those projects activated during this year are documented under Part Two. Completed projects on the other hand, have been written up and published as technical reports to aid the transfer of the results to industry as well as for exploitation by public sector agencies. The Institute has been charged under the Second national development plan to intensify operational activities for the commercial development of research results. In pursuance of this, a legal notice was promulgated during the year which established a Revolving Fund with an initial capital of £15,000 for the purpose of setting up pilot plants to demonstrate the technical and commercial feasibilities of new processes and products developed in the Institute. Another significant event designed to increase the thrust of disseminating information on research results and other activities of the Institute was marked by the launching of a new publication entitled "Technical Information Bulletin for Industry". This magazine which is issued every quarter presents in a profile the investment opportunities arising from studies carried out in the Institute.

3. At the instance of the Nigerian Council for Science and Technology, the Institute carried out a survey and study of the relevance of scientific and technological research to industries in Nigeria. The report which has since been submitted, brought out a number of revealing but challenging problems limiting the impact of research on the development and performance of Nigerian industry. It was for example observed that while a considerable amount of research potential as well as relevant experimental results exist in Nigerian Research Institute and University departments, there was very little interest shown in them by expatriate managed industrial organisations because of their total dependence on parent company research facilities. In comparing our observations with those expressed in a similar study carried out on a world wide basis, we formed the impression that research relevance with industry both in the developed and developing countries was largely achieved through a contract system between the researchers and the users. In the developing countries where such contracting services are at a rather low level of development between industry and local research institutions, government intervention is a *sine qua non*.

4. Three Federal Permanent Secretaries—Mr A. A. Ayida (Finance), Mr P. C. Asiodu (Mines & Power) and Mr I. J. Ebong (Economic Development and Reconstruction) made a special visit to the Institute during the last quarter of the year. The occasion was a particularly welcome one for it brought into public focus, the positive elements of necessary interaction between industrial research programmes and national economic policy planning. Other important visitors to the Institute are indicated in subsequent pages. The increasing number of student, institutional and state group visits reflect a growing awareness of the contributions of the Institute to the industrial development of the country.

ADMINISTRATION AND GENERAL

One of the remarkable features of the Institute during the period 1st April, 1972 to 31st March, 1973, was the high turn-over of staff. Altogether, some 34 additional staff were appointed but 18 were lost through resignations, transfers, and terminations. For details, *see* pp. 4-5. In spite of this, however, the staff applied themselves diligently and much progress was achieved as the report of the various Divisions recorded hereafter illustrate. For example, the Engineering and the Food Science and Technology Divisions completed the installation of the pilot plants for mechanised production of gari, while the Niro atomiser was erected for the production of soy-ogi on a quasi commercial scale. These are by no means cheap achievements, considering the impact the mechanical production of gari and soy-ogi has made in scientific and industrial circles at home and abroad.

Another significant achievement of the period covered by this report is the firm establishment of the Industrial Analysis Division. Founded for the dual purpose of evaluating the economic potentials of F.I.I.R research projects and of rendering service to local industries, the Division is now functioning effectively, thanks to the Ford Foundation which provided a Business Management expert who provided the initial guidance needed by the young Nigerian graduates recruited to the Division.

Other important activities and events at the Institute are briefly described in the following paragraphs, but mention must be made here on the visit of two eminent scientists because of the importance of their visits to the Institute. Professor J. P. Blackledge of the Denver Research Institute, Denver, Colorado, spent eight days at the Institute attending a meeting called to prepare a report on the relevance of scientific research to local industries. The theme of the report is of special interest to F.I.I.R and constitutes the bed-rock of the linkage which now exists between F.I.I.R and D.R.I. The other valued visitor was Dr R. Banks, a Ford Foundation consultant who came to the Institute to study its operations research and industrial engineering needs and make recommendations.

Apart from the research engagements of staff in their laboratories, several found time to attend international conferences and to undertake study tours. For example, the Director of Research—Dr I. A. Akinrele—attended and presented a paper to the International Conference on 'Chemical Engineering in the Service of Mankind' in Paris, France from the 2nd to 9th September, 1972. Before the conference, he made a stop-over in London to visit the Tropical Products Institute and also called at their branch in Culham Industrial Technical Department—for discussion on the Composite Flour Project jointly operated by the Tropical Products Institute and this Institute.

Also, the Director attended a UNIDO Seminar on Industrial Information in Addis Ababa from 6-15 November, 1972. This Seminar sprang from an awareness that Industrial Information is a special area of industrialisation that should be properly organised to facilitate the industrialisation process of developing countries.

He also served as a consultant to the United States National Academy of Engineering in Washington D.C. on the establishment of an International Industrialisation Institute.

TOURS WITHIN THE COUNTRY

Different officers of the Institute undertook various tours of many establishments in different parts of the Federation during the year. Among them was Dr A. B. Oniwinde who went on an official tour of the South-Eastern State, and visited many towns including Calabar—the State capital.

Dr M. V. Rajagopal, a Senior Research Officer and head of the Processing Division of the Institute, went on tour to the Northern States, during which he visited Kaduna, Kano and Jos, and had useful discussions with industrial establishments.

In August, a group of officers from this Institute visited the Nigerian Paper Mills Ltd., Jebba. They held talks with the Works Manager and reached agreement on bilateral co-operation between the two organisations in industrial research work. Various operational units of the factory and their finished products were seen.

STUDY TOURS AND TRAINING FACILITIES

In order to enhance the efficiency of the Institute's personnel, training facilities were made available to officers in different fields.

Mr B. Amodu, Workshop Supervisor who has been on a Management Supervisory course/ tour since March, 1972, returned to the Institute on 6th October, 1972 on the successful completion of his course.

The Acting Deputy Director of Research, Dr G. O. Chigbo, went on a study tour of various ceramic institutions in the United Kingdom. Among the places he visited are : Brick Development Association, London, National Federation of Clay Industries and the British Ceramic Research Association in Stoke-On-Trent, England. This tour was undertaken in order to gain on-the-spot knowledge of the latest techniques in ceramic technology.

Other officers who benefited from the training programme included Mr T. A. O. Akinola who undertook a study tour of some electrical Industries in the United Kingdom ; Mr L. I. Ogueri who undertook a three-month study course under the United Kingdom Technical Aid Scholarship and Dr A. K. Fasina, a Senior Research Officer, who was awarded a Fellowship by UNIDO to study in the U.S.A. for three months. Mrs A. O. Kuboye was awarded a one-year scholarship to study at Strathclyde University, Wales, England, under the United Nations Technical Assistance Programme. She is expected back at the Institute at the end of her course in the fourth quarter of 1973.

The following staff changes took place in the Institute during the year 1st April, 1972 to 31st March, 1973.

NEW APPOINTMENTS

<i>Name</i>	<i>Rank</i>	<i>Date</i>
Mr D. I. Nnodim	Library Assistant, Grade III	11-7-72
Mr N. I. Ishola	Daily Paid Motor Driver	18-7-72
Mr B. Ogunnaiya	Clerical Officer	19-7-72
Miss F. Adefila	Senior Technical Assistant, Grade III	24-7-72
Mr D. D. Nwaohiri	Pupil Research Officer	25-7-72
Mr O. O. Akinnowo	Pupil Research Officer	21-9-72
Mr A. C. Aso	Pupil Research Officer	11-10-72
Mr I. E. Imaghodor	Artisan, Grade II	31-10-72
Mr N. O. Ajayi	Technical Officer	3-11-72
Miss O. A. Gibson-Roberts	Pupil Research Officer	20-11-72
Mr E. O. Lalere	Library Assistant, Grade III	12-12-72
Mr J. Ebami	Clerical Officer	12-12-72
Mr C. Iwunze	Senior Technical Assistant, Grade II	18-12-72
Miss G. Otobrise	Library Assistant, Grade III	19-12-72
Mr J. Oke	Clerical Officer	20-12-72
Mr M. O. Karigidi	Senior Technical Assistant, Grade II	27-12-72
Mr A. C. Asogu	Storekeeper, Grade III	29-12-72
Mr C. S. U. Eleonu	Stenographer, Grade II	6-1-73
Mr J. O. Ogundimiyo	Artisan, Grade II	17-1-73
Mrs Y. S. Habib	Stenographer, Grade II	24-1-73
Mr A. O. Sadiq	Stenographer, Grade II	24-1-73
Mr F. I. Igboalusi	Technical Officer	30-1-73
Mr R. A. Adewunbi	Senior Technical Assistant, Grade II	1-2-73
Mr O. I. Oni	Senior Technical Assistant, Grade II	1-2-73
Miss Doyin Olawoye	Senior Technical Assistant, Grade II	1-2-73
Mrs F. I. Olayinka	Cook	1-2-73
Miss A. A. Akiba	Assistant Cook	1-2-73
Mr C. T. Onuoha	Pupil Research Officer	8-2-73
Mr F. N. Igwilo	Pupil Research Officer	14-2-73
Dr E. O. Umeh	Research Officer, Grade I	22-2-73
Mr M. E. Edeigba	Technical Officer	1-3-73
Miss A. K. Akinmoladun	Clerical Officer/Receptionist	7-3-73
Mr Titilayo Lamina	Assistant Industrial Analyst	9-3-73
Mr A. O. Olunloyo	Temporary Research Officer, Grade I	16-3-73

TRANSFERS

<i>Name</i>	<i>Rank</i>	<i>From</i>	<i>To</i>	<i>Date</i>
Mr T. Shambe ..	Research Officer, Grade I	F.I.I.R. Oshodi ..	Veterinary Research Centre, Vom	31-8-72
Mrs B. F. Adebayo	Research Officer, Grade II	West State Civil Service	F.I.I.R., Oshodi	27-9-72
Mrs R. B. Dada ..	Typist, Grade III	Federal Ministry of Industries, Lagos	F.I.I.R., Oshodi	4-11-72
Mrs A. D. Adebayo	Confidential Secretary, Grade II	F.I.I.R., Oshodi	Nigeria Police Force, Port Harcourt	31-1-73

RESIGNATION OF APPOINTMENT

<i>Name</i>	<i>Rank</i>	<i>Date</i>
Mr J. I. Zannu	Senior Technical Assistant, Grade II	31-7-72
Mr A. Adebajo	Library Assistant, Grade III	20-8-72
Mr F. Aderemi	Assistant Technical Officer	23-9-72
Miss N. Obi	Senior Technical Assistant, Grade II	11-9-72
Mr S. O. Udeh	Clerical Officer	20-10-72
Mrs B. F. Adebayo	Research Officer, Grade II	18-11-72
Mr O. O. Akinnawo	Pupil Research Officer	2-1-73
Mr T. A. B. Faleye	Pupil Research Officer	2-1-73
Miss M. I. Olowora	Clerical Officer/Receptionist	4-1-73
Miss O. O. Akindele	Storekeeper, Grade III	23-1-73
Mr N. O. Ajayi	Technical Officer	19-3-73

TERMINATION OF APPOINTMENTS

<i>Name</i>	<i>Rank</i>	<i>Date</i>
Mr D. Adetuyi	Senior Technical Assistant, Grade II	31-1-73
Mr M. Bakare	Daily Paid Messenger	16-2-73
Miss B. O. Adu	Storekeeper, Grade III	1-3-73

PROMOTIONS

The following promotions were effected during the year ending 31st March, 1973.

<i>Name</i>	<i>Rank</i>	<i>Effective Date</i>
Mr J. A. Dina	Principal Research Officer	1-9-72
Dr A. O. Koleoso	Principal Research Officer	1-9-72
Dr A. K. Fasina	Senior Research Officer	1-9-72

ACTING APPOINTMENTS

The following acting appointments were made :

<i>Name</i>	<i>Posts</i>	<i>Effective Date</i>
Dr G. O. Chigbo	Deputy Director	1-6-72
Mr F. O. Olatunji	Senior Research Officer	1-6-72
Dr E. O. Ofulue	Senior Research Officer	30-10-72
Mrs A. O. Kuboye	Research Officer, Grade I	6-6-72
Mr T. O. A. Akinola	Research Officer, Grade I	7-9-72
Mrs B. L. Ariyo	Research Officer, Grade I	30-10-72
Mrs O. Gbadamosi	Higher Technical Officer	1-6-72
Mr M. A. O. Omofade	Research Officer, Grade II	10-7-72

MANPOWER AVAILABILITY

Scientific Senior Staff	43
Administrative Senior Staff	6
Scientific Junior Staff	20
Administrative Junior Staff	42
Scientific Supporting Junior Staff	40
Special and General Labour	65
Total	216

VISITORS TO THE INSTITUTE

J. O. Arazu	7 Bombay Crescent, Apapa
D. Halliday	T.P.I., London
F. Akinkugbe	Food Specialities, Ilupeju
F. O. Okulaja	Custom and Excise, Lagos
D. B. Thomas	Bloomington, Indiana, U.S.A.
J. O. A. Akintola	N.I.S.E.R., University of Ibadan
C. S. Okoro	Investment Centre, Lagos
S. O. Fadahunsi	13 Breadfruit Street, Lagos
M. A. Oladele	Nigerian Institute of Management
C. U. Nwaguma	Labstock (Nig.) Limited
S. I. Lawson	Johns Manville (W.A.), Lagos
F. N. O. Anyakora	N.C.R., Lagos
Prof. J. P. Blackledge	Denver Research Institute, Colorado, U.S.A.
Messrs Stewart and Gray	British High Commission
Teiteya A. Dacrose	Nigerian Distillers and Breweries Limited
A. Hyvavinen	Ethiopian Nutrition Institute, Addis-Ababa, Ethiopia
G. R. D. Haper	Wand T. Avery Limited
I. Ndaeyo	Ministry of Agric., S.E.S., Nigeria
K. A. Aderogba	Nigerian Paper Mills Limited
Dr R. Banks	Ford Foundation
Mr P. F. Giger	U.T.C., Lagos
Dr G. E. Okoloko	University of Benin, Mid-West
Students of the Federal Department of Forestry	School of Forestry, Ibadan
G. A. Hewitt and G. M. Newell Dunford	BEWAC Limited, Lagos
Chris Ikeokwu	Daily Times, Lagos
G. A. B. Knapton	F.A.O., Rome, Italy
Dr M. H. Zehui	University of Ife
Dr S. N. Mbagwu	University of Nigeria, Nsukka

ACCOUNTS SECTION

Nigeria changed to Decimal Currency with effect from 1st January, 1973—the last quarter of the year under review. In spite of this change at a later date all amounts in the subjoined schedule are in decimal currency. By excluding sub-heads 48 (Personal Emoluments) and 53 (Labour) which are controlled at the Headquarters and limiting comments to other sub-heads controlled by the Institute, the position as presented at (ii) below is that out of an approved expenditure of ₦94,400.00 the sum of ₦87,512.00 was expended. This gives an unspent balance of ₦6,888.00 which got lapsed after 31st March, 1973.

Sub-head 52 (Motor Vehicles : Maintenance and Running Cost) was over-spent to the tune of ₦1,154.00. This was due to increased expenditure on the increase on the fleet of vehicles.

STATEMENT OF EXPENDITURE FOR THE YEAR
ENDED 31st MARCH, 1973

Sub-head	Detail of Expenditure	Approved Provision	Actual Expenditure	Balance at 31-3-73
		N	N	N
48	Personal Emoluments	329,018	217,639	111,379
49	Local Transport and Travelling	7,400	6,369	1,031
50	Office and General	2,800	2,405	395
51	Libraries	3,000	2,521	479
52	Motor Vehicles : Maintenance and Running Costs	3,000	4,154	1,154
53	Labour	34,680	28,340	6,340
54	Semi-permanent and Temporary Buildings	1,200	1,064	136
55	Utility Services	12,000	11,511	489
56	Consultants and specialists fees and allowances	5,000	1,588	3,412
57	Upkeep of Laboratories and Equipments	7,000	6,985	15
58	Materials and Stores	7,000	6,946	54
59	Upkeep of Workshop and Machinery	3,000	2,934	66
60	Maintenance of Permanent Buildings and Roads	2,000	1,903	97
61	Industrial Promotion	4,000	2,313	1,687
62	Office Furniture and Equipment	2,000	1,904	96
63	Motor Vehicles	6,000	5,976	24
64	Conversion of Workshop into Guest Houses for Consultants	12,000	11,939	61
65	Data Processing	17,000	17,000	Nil
	(i)	458,098	333,491	124,607
	(ii)	94,400	87,512	6,888
Head 622—Capital Expenditure Sub-head 106— F.I.I.R., Oshodi		386,000	81,040	304,960

STORES DIVISION

SUMMARY

PURCHASES :	£	s	d
April-June 1972	10,786	1	11
July-September 1972	4,160	11	2
October-December 1972	13,464	16	9
January-March 1973	49,677	8	3
	68,088	18	1

ORDERS RECEIVED :

							£	s	d
April-June 1972	..	..	..	..	..	..	11,268	17	9
July-September 1972	..	..	..	..	..	..	4,357	1	1
October-December 1972	..	..	..	..	..	..	14,999	11	1
January-March 1973	..	..	..	..	..	..	2,815	—	7
							33,440	10	6

ORDERS *not* RECEIVED :

							£	s	d
April-June 1972	..	..	..	..	..	..	10,795	1	7
July-September 1972	..	..	..	..	..	..	16,536	12	6
October-December 1972	..	..	..	..	..	..	23,466	3	6
January-March 1973	..	..	..	..	..	..	21,264	3	7
							72,062	1	2

ISSUES

							£	s	d
April-June 1972	..	..	..	..	..	..	6,852	—	2
July-September 1972	..	..	..	..	..	..	3,634	5	4
October-December 1972	..	..	..	..	..	..	8,367	6	6
January-March 1973	..	..	..	..	..	..	11,430	17	—
							30,284	9	—

GRAND TOTAL FOR THE 1972-73 FINANCIAL YEAR

							£	s	d
1. Purchases	..	..	..	..	..	..	68,088	18	1
2. Orders received	..	..	..	..	..	..	33,440	10	6
3. Orders not received	..	..	..	..	..	..	72,062	1	2
4. Issues	..	..	..	..	..	..	30,284	9	—
5. Total	..	..	..	..	..	..	203,875	8	9
6. Minus Issues	..	..	..	..	..	..	30,284	9	—
							*£173,590	19	9

INDUSTRIAL ANALYSIS DIVISION

During the period under review the first batch of Nigerian staff members joined the Industrial Analysis Division. The primary activities of the Division were directed towards on-the-job training of these new staff members. In this respect, Dr A. Beenhakker as the Pioneer Head of the Division prepared a number of background papers for the present and future use of the Division's staff members.

DR A. BEENHAKKER,
*The Pioneer Head of the Industrial
Analysis Division*

The papers included :

1. "Study of the Market—Definitions"
2. "Study of the Market—Analysis of Current Demand"
3. "The Study of the Market—Demand for Intermediate and Capital Goods"
4. "Project Engineering—I"
5. "Project Engineering—II"
6. "A Bird's Eye View of Operational Research"
7. "Production Management—Demand Forecasting"
8. "Production Management—Allocation of Resources."

In addition to his work at the F.I.I.R., Dr Beenhakker presented a number of guest lectures at the Nigerian Institute of Management ; the University of Lagos and the University of Ibadan. These lectures covered statistical analysis, exponential smoothing, linear programming, production scheduling, financial analysis and demand forecasting. He prepared, in co-operation with the staff of the Lagos University School of Administration, a case study for the use of the students. During his leave, he presented lectures on the applications of Operations Research Techniques for investment decisions at a number of universities in the U.S.A. Dr Beenhakker also participated in policy formulation exercise of the Indigenisation Board.

Research projects carried out by the Division included :

(a) Preparation and Publication of Information Manuals

(i) *Industrial Manual*, 1973.—This manual was designed to aid potential investors in Nigeria's industrial sector. It includes information regarding Government policies and regulations, appropriate sources of finance, labour regulations, availability of skilled and unskilled labour, transportation facilities, technical and management consulting services. Where necessary, a differentiation according to type of industry is introduced in view of the relevant particulars, such as Government regulations regarding taxation and potential sources of finance.

Senior Members of Industrial Analysis Division, Reviewing completed projects of the Institute.

(ii) *Manual of Industrial Applications of F.I.I.R.'s Research Projects*.—In order to inform potential investors of the industrial applications and viability of F.I.I.R. research projects the preparations of this manual has been initiated. The manual will contain information about the market potential, the capital and technical requirements for the establishment of the relevant industries, estimates of the profitability of the projects, as well as other relevant information of interest to potential entrepreneurs.

(b) Economic and Statistical Evaluation of F.I.I.R.'s Research Projects

(i) *Feasibility Study of Nico Cream*.—This project was initiated as a comprehensive study of the futuristic opportunities of Nigeria's cocoa-based industries, to highlight the potentiality of Nico cream, which utilises cocoa butter. Two market surveys have been

carried out In the first of these 80 samples of Nico cream were distributed amongst students at the University of Lagos to test consumer reaction to the product. The second survey was more extensive, although restricted to the Lagos area. Analysis of the returned questionnaires is at the initial stage.

(ii) *Market Study of Vinegar from Palm Wine.*—A market study is being carried out in the Lagos area to estimate the current and potential demand for vinegar made from palm wine. The investigation involved data collection with regard to the periodic sales volume of vinegar, as well as the periodic local production and importation of vinegar.

(iii) *Market Study on modified Starch for Textiles.*—The analysis of the potential demand for modified starch for textiles was carried out by Ujamaa Consultants Limited. The report indicated the existence of a market for this product that justifies the establishment of its commercial production.

(iv) *Study of the commercial establishment of cassava based foods.*—A methodology was developed for an extensive study of investment proposals for increasing Nigeria's cassava production and establishing cassava-based industries.

(c) Investment Evaluations in Nigeria's Industrial Sector.

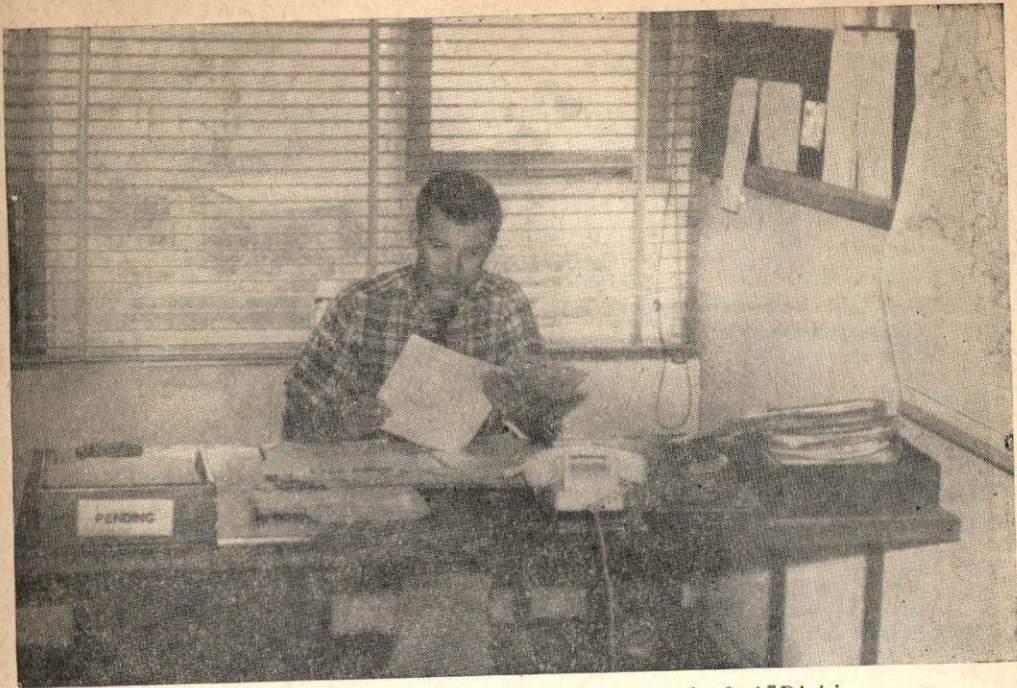
(i) *Evaluation of a coconut-based industry.*—An extensive study regarding the feasible utilisation of Nigeria's coconuts was completed. This study led to the recommendation that the production of dessicated coconut as well as the extraction and processing of coir have lucrative investment prospects provided certain conditions are met. The report has been partially re-written for purposes of publishing as a Technical Memorandum.

(ii) *Feasibility Study of Tomato Canning in the North-Central State.*—At the request of the Ministry of Trade, Industry and Co-operatives of the North-Central State, a feasibility Study of tomato canning was initiated. A detailed methodology, prepared and forwarded to this Government dwells, primarily, on the estimation of the current and projected demand for tomato products, including national consumption patterns ; the determination of the anticipated supply of fresh tomatoes over the next five years, noting the various supply constraints ; the determination of the technical co-efficients and technical requirements of a tomato processing factory ; the preparation of annual cost estimates and profitability forecasts ; and the determination of the best suitable marketing and financing arrangements for the industry.

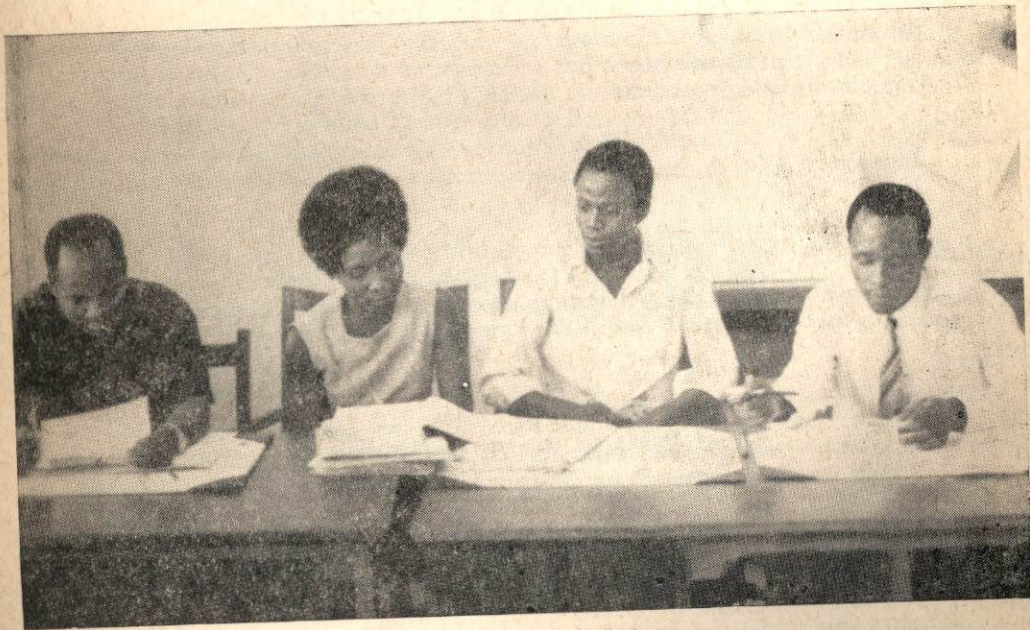
(iii) *Investigation into the creation of stimuli for Industrial Activity.*—In order to encourage indigenous businessmen to participate more significantly in the further industrialization of Nigeria and to help implement the 'Indigenisation Decree', various methods are being investigated whereby stimuli can be found or created to increase industrial activity. One of these is the investigation of means to activate the present low level of trading at the Stock Exchange. In addition the possibility of establishing a Holding Company that would set up demonstration plants at various locations in the country is being looked into. This Holding Company would be initially owned by the Federal Government which would eventually sell shares to citizens. The organisation would include units to acquire necessary inputs and to distribute and sell output.

One other area which is being examined is the identification of missing links within the Nigerian industrial setup and how to fill these gaps.

(d) *Programming of F.I.I.R.'s Activities* Information about F.I.I.R.'s current, internal management system has been collected, documented, and analysed. The results indicate that possible improvements regarding the scheduling of various activities and inventory management can be made if programming in physical terms, is emphasized as against financial planning without sufficient attention to the timing of physical requirements. Future, desirable action is being carefully formulated.



Dr Arie Beenhakker—pioneer Head of Industrial Analysis Division



Team work at the Industrial Analysis Division

LIBRARY

ACQUISITIONS AND ACQUISITION WORK

Most of the books ordered from our local book suppliers arrived before the end of the financial year. In all, new addition total, 1,038. Among these materials is a set of the latest edition of Encyclopaedia Britannica, a very useful reference tool.

29 new titles of periodicals were added to our standing order with the Crown Agents and most of the journals on order have been received. This brings to 69 the number of periodicals on standing order. Claims for missing issues of periodicals which was started in the quarter July-September have helped considerably to reduce the gaps in our collection of periodicals. As a result of this exercise it will be possible to bind certain sets of periodicals which hitherto could not be bound because of missing numbers. Accessions for the year are shown in table I below. Books received total 541 from various sources.

PURCHASE

Out of the library vote ₦1,500 about ₦600 was spent on the purchase of books whilst ₦500 on periodicals. All invoices were processed and settled by the accounts section.

TABLE I—ACQUISITIONS

								1971-72	1972-73
A. Books									
Total books requested ..	..	..	..	..	..	..	..	83	—
Books recommended for purchase ..	..	..	..	..	..	..	..	36	65
Orders received ..	..	..	..	..	..	..	..	23	47
Outstanding Order ..	..	..	..	..	..	..	..	13	18
B. PERIODICALS									
Titles on standing order ..	..	..	..	..	..	..	..	37	69
Local subscription (Newspapers and periodicals) ..	..	..	..	..	..	..	..	10	12
Subscription through Institutional ..	..	..	..	..	..	..	..	10	10
Membership of Associations ..	..	..	..	..	..	..	..	—	200
Periodical from other sources ..	..	..	..	..	..	..	..	—	—
C. OTHERS									
Reprints ..	..	..	..	..	..	..	..	18	60
Slides ..	..	..	..	..	..	..	..	28	16
Microfilm ..	..	..	..	..	..	..	..	—	—

GIFTS AND DONATIONS

122 gifts mainly of UNIDO publications were received during the year from Government Agencies, other organizations and Institutions, (Table II).

Exchange

Publications received by exchange totalled 20.

TABLE II—RECEIPT BY SOURCE

By Gift and donations

	1971-72	1972-73
Books ..	197	122
Periodicals ..	265	200

Circulation and Loans

Accessions—541 items were accessioned and 2,032 issues of periodicals were received and circulated to officers.

TABLE III—ACCESSIONS

							1971-72	1972-73
Books	..	..	..	..	..	..	295	541
Periodicals issues	..	..	..	..	..	..	234	2,032

TABLE IV—LOANS

							1971-72	1972-73
Books	..	..	..	..	..	..	1,078	696
Periodicals	..	..	..	..	..	..	223	510

The number of books borrowed by readers, mostly institutes' officers this year is considerably less than that of last year probably because many officers went on vacation leave during the Oct-Dec. quarter and also because the number of books each officer could borrow at a time was limited to six, since the adoption of the Brown charging system, which went into operation on the 1st of June, 696 books and 510 issues of periodicals were borrowed by officers and other privileged readers.

Circulations

Technical Information Bulletin for Industry, Vol. 1, No. 1, 1972, Vol. 2, No. 1, 1973, Vol. 2, No. 2, 1973, F.I.I.R. Annual Report 1970-71 were distributed to all the names on our mailing lists and to others on request, gratis.

Reference

Several requests including mail enquiries were received for information on various topics. Most of them were from prospective entrepreneurs and organization interested in the commercialisation of the three completed projects namely—Production of Vinegar from Palm wine, Distillation Apparatus for Crude Alcohol and Desiccated Coconut production in Nigeria, which were highlighted in the various issues of our Technical Information Bulletin for Industry, launched in December 1972. Routine reference work was also carried out for officers of the Institute.

In order to facilitate easy access and retrieval of information from reference books, these materials have been separated from loanable books and shelved separately, with the quick reference material, comprising telephone directories, trade directories, government publications year-books, etc. shelved on the Librarian's desk.

Cataloguing and Classification

With the receipt of printed catalogue cards produced for us by the National Library, (see April-June Quarterly Report) and with the systematic filing of these cards in the standard Catalogue cabinet purchased through the National Library, the nucleus of a real library catalogue was formed.

This catalogue which will eventually replace the present one is expected to grow fast, as we plan to catalogue all the new books at present in the library and recatalogue those previously catalogued on 4 × 6 cards. With a typist being trained for us by the National Library to prepare catalogue entries on Duplimat master plates, and with the proposed purchase of a printing machine capable of handling these Duplimats, it would not be long before we accomplish full internal production of these cards.

1. *Cataloguing*

	1971-72	1972-73
Total titles	3,242	3,462
New titles catalogued	330	220
Titles in Process	—	200
Titles awaiting cataloguing	36	154

Subject Cataloguing

Total titles	—	—
New titles classified and subject headed	—	—
Titles awaiting subject cataloguing	—	220

STOCK

A general review of stock aimed at updating materials and replacing missing ones was carried out. Standard reference books were also reviewed and a large order placed for their current editions. A critical review of our periodical holdings was also carried out and this has resulted in an enlargement of our periodicals holding.

We also reviewed our holding of British Standards for which the library is a depository, superseded issues were weeded out and transferred to the stores. In order to fill the gaps now existing in our collection, missing issues were requested from the issuing authority.

Research reports, technical memoranda, annual reports and other Institute's publication are now well-arranged and housed in purposely made pigeon holes and prominently labelled for easy retrieval. The library stock as at 31st March, 1973 is shown in table III below.

Library stock as at 31st March, 1973

TABLE III—LIBRARY STOCK

<i>Items</i>	1971-72	1972-73
Books (Classified)	2,242	3,462
Unclassified materials	—	—
Bound Periodicals (excluding <i>gazettes</i>)	493	596
Periodical titles	711	—
Trade Catalogues	530	580
Instruction Manuals or Handbooks	85	100
Reprint (copies)	—	—
Maps	11	26
Atlases	6	6
Negatives	190	235
Slides	40	56
Microfilm (rolls)	46	46

Photoduplication

The production of photocopies has been completely taken over by the library with the transfer of the Apeco Machine to the library, where it will be housed temporarily until a more suitable place is found. Over 5,068 pieces of items comprising mainly of articles in journals and various official documents were reproduced or photocopied.

Bindery

103 volumes of periodicals and 42 publications were bound in this section. 400 book pockets were made and many reams of paper printing and typing paper were cut into various sizes.

Printing

This section was actively engaged in printing many of the Institutes publications including the Technical Information Bulletin for industry, quarterly Progress reports and "feasibility report on Desiccated Coconut production in Nigeria. Several other minor printing jobs were also undertaken. After the efforts to get one of our junior members of staff trained in offset lithographic printing at the Government Printing Press failed, a second training on the use of Multilith Offset 125WL machine was arranged with Atlas, the supplier, for two members of our staff. The quality of our output has improved considerably as a result of this arrangement.

Publications 1972-73

1. An inquiry into the Possibility of Desiccated Coconut Processing Industry in Nigeria by Arie Beenhakker and B. C. Okere.
2. Utilization of available resources : a compendium regarding Nigeria's coconuts by Arie Beenhakker and B. C. Okere.

Articles in Journals 1972-73

<i>Journal</i>	<i>Title</i>	<i>Author</i>
<i>Management in Nigeria</i> Vol. 7, No. 5, March/April, 1972, pp. 177-182.	Imperatives of Modern Technology for Indigenisation.	I. A. AKINRELE (DR)
<i>Nigerian Investment Centre</i> No. 3, Sept. 1972, pp. 8-13.	Prospects for Coconut Processing industry in Nigeria.	S. ANNON
<i>Experiments in Physiology and Biochemistry</i> , Vol. 5, pp. 273-292, 1972.	The Determination of histamine content of tissues.	G. N. WOODRUFF (DR) and A. B. ONIWINDI (DR)

PAPERS DELIVERED AT CONFERENCES, SEMINARS, MEETINGS, ETC., 1972-73

<i>Venue and Date</i>	<i>Title</i>	<i>Author</i>
<i>University of Ife, Ile-Ife</i> , 11th April, 1972.	Perspectives of the protein enrichment of industrially prepared gari.	I. A. AKINRELE, H. M. JOSEPH (MISS) R. O. OKOTORE F. O. OLATUNJI
<i>Nigerian Institute of Management</i> , 22nd June, 1972.	Linear programming.	A. BEENHAKKER (DR)



Readers using the Institute's Library

PAPERS DELIVERED AT CONFERENCES, SEMINARS, MEETINGS, ETC., 1972-73—continued

<i>Venue and Date</i>	<i>Title</i>	<i>Author</i>
Ibadan Polytechnic, 14th-15th Dec., 1972.	Training for Industrial Employment.	I. A. AKINRELE (DR)
Symposium on the Role of Microbiology in National Development by the Nigerian Society for Microbiology held at the University of Lagos on 19th Dec., 1973.	Role of Microbiology in Industrial Production.	M. V. RAJAGOPAL (DR)
Staff Seminar held at F.I.I.R., Oshodi on 3rd February, 1973.	Policy and Programme Guideline of the F.I.I.R. for the 3rd National Development Plan.	I. A. AKINRELE (DR)
Staff Seminar held at F.I.I.R., Oshodi on 17th February, 1973.	Composite flours for the Baking Industry.	A. W. JAMES
Staff Seminar held at F.I.I.R., Oshodi on 10th March, 1973.	Library Services and Documentation at the F.I.I.R.	B. ARIYO (MRS)
Staff Seminar held at F.I.I.R., Oshodi on 17th March, 1973.	Investigation and characterisation of natural and derived flavour essences of industrial Interest.	S. I. AHONKHAI (DR)
Staff Seminar held at F.I.I.R., Oshodi on 31st March, 1973.	Pulping Trials on selected Nigerian Plant Materials.	J. O. ALOKWEM

DOCUMENTATION

This section continues to make progress particularly in the area of dissemination of Industrial Information. It has been primarily involved in the active dissemination of the results of the Institutes research to Industry by means of our "Technical Information Bulletin" which was launched in Dec. 1972. The primary purpose of this bulletin is to communicate scientific and technological information to industry and other interested parties.

We have assisted in procuring specific documents and in searching for particular information about specific subjects. Those beyond our present scope were passed on to UNIDO Industrial Information Service for action.

A documentation of materials on industry in Nigeria has been started and it is hoped that a comprehensive bibliography will be published as soon as all necessary information has been collected. Work has also started on the preparation of a list of sources of statistical data needed for the evaluation of industrial investments, listing all feasibility and market survey reports projects available in the country. Questionnaires have been sent to various organisations and enterprises in this respect.

Publications received from UNIDO have formed the nucleus of our collection for industrial information. New additions are expected from local sources. The response to our request for publications for the Documentation Centre has been very encouraging. A bibliographical list was prepared for our Technical Memoranda No. 27 on Desiccated Coconut Production in Nigeria. Efforts are being made to continue the publication of abstracts which has been suspended for some time. It is hoped that this section when fully established will be able to offer a wide range of services to industry and the public.

PART TWO—RESEARCH AND DEVELOPMENT
RESEARCH PROJECTS (1972-73)
FOOD DIVISION

Ag. Head : DR A. K. FASINA, B.Sc., Ph.D., D.A.C., A.R.I.C.

1. *Toxicological evaluation of Soy-Ogi, a protein enriched staple cereal in Nigeria.*
Researchers : A. B. Oniwinde and I. A. Akinrele.
2. *Production of Composite flours from local cereals and Tubers to substitute wheat flours partially or wholly.*
Researchers : T. Shambe, W. E. James and F. A. O. Osinowo.
3. *Development of Malt from local grains for brewing fermented alcoholic beverages.*
Researchers : J. A. Dina, R. A. Okotore, A. B. Meadows.
4. *Microbial flora of Nigerian foods—*
H. M. Joseph, D. O. Gibson-Roberts and I. A. Akinrele.
5. *Protein enrichment of gari.*
Researchers : H. M. Joseph (Miss), R. O. Okotore and I. A. Akinrele.

INDUSTRIAL CHEMISTRY DIVISION

Head : DR O. A. KOLEOSO, M.Sc., Ph.D., F.C.S., M.C.I.C.

FIBRES AND TEXTILES

6. *Modification of Cassava Starch for sizing and finishing of Textile Fabrics.*
Researcher : L. L. Akerele.
7. *Preparation of instant natural indigo for local fabric dyeing.*
Researcher : I. Aladeselu.
8. *Pulping trials on selected Nigerian Plant Materials.*
Researchers : J. O. Alokwen and A. O. Ogunle.

CERAMICS AND PHYSICAL CHEMISTRY SECTION

9. *Industrial Evaluation of Nigerian Clays.*
Researchers : E. Ofulue, O. S. Imoukhuede and G. O. Chigbo.

ORGANIC CHEMICALS SECTION

10. *Utilisation of Nigerian Vegetable Oils and Fats.*
Researchers : O. A. Koleoso and K. Rowland.
11. *Flavours and Essences.*
Researcher : S. I. Ahonkhai.

PROCESS ENGINEERING DIVISION

Head : DR M. V. RAJAGOPAL, M.Sc., Ph.D.

INDUSTRIAL PROCESSING SECTION

12. *Mechanised Peeling of Cassava Roots.*
Researchers : F. O. Olatunji, L. Ogueri and M. V. Rajagopal.
13. *Manufacture of Gari and Soy-Ogi.*
Researchers : B. Amodu and K. Oniya.

GENERAL ENGINEERING SERVICES DIVISION

Head : DR M. I. O. ERO, M.S.C.,

14. *Drying of Agricultural Products.*

Researchers : M. A. O. Omofade and M. I. O. Ero.

15. *Cassava Peeler.*

Researchers : F. O. Olatunji, M. I. O. Ero and I. A. Akinrele.

INDUSTRIAL ANALYSIS DIVISION

Head : DR A. BEENHAKKER, M.A., Ph.D.,

INDUSTRIAL PROFILES SECTION

16. *Market Surveys of Consumer Products.*

Researchers : A. Falua (Miss) and A. Beenhakker.

17. *Investment analysis of completed research projects of the Institute.*

Researchers : B. C. Okere and A. Beenhakker.

DOCUMENTATION SECTION

18. *Promotional support of the F.I.I.R.O.'s Research Projects.*

Researchers : B. L. Ariyo (Mrs) and R. O. Sodipe.

FOOD RESEARCH

(a) *Composite Flour*

A country-wide tour of bakery establishments was undertaken, during which sixty-three bakeries and three allied research institutions were visited. The tour confirmed, amongst other things that :

(i) the baking industry is very large and is still expanding ;

(ii) the straight-dough technique is employed and this involves the usual mixing of all ingredients into a dough, fermentation of the dough for 3-6 hours, using a "dough brake" for breaking up the dough (milling), scaling to different loaf-sizes and hand-moulding (some big bakeries use machine), proofing and oven-baking ;

(iii) the bread weights vary considerably and a typical examples is the ten-kobo loaf, whose weight varies from 315g to 596g whereas the standard should be 453g.

It is important to note that modern technology has dispensed with the dough-brake technique since the advent of efficient mechanical and high speed mixers which eliminate the long fermentation time and still produce smooth and thoroughly mixed doughs.

Using the equipment kindly donated to this Institute by the British Government, physical and baking tests were carried out on the composite flour produced at the Institute in order to ascertain their suitability for bread making. The physical and chemical characteristics of the bread produced from the composite flour by the modern technique of mechanical dough development were determined. Thus it was possible to develop standard test-baking procedures adapted from the usual Nigerian baking practice. Procedures have also been established for both the Chorleywood Bread Process (CBP) using the Tweedy High Speed Mixer and the Gilbert High Speed Mixer and for a traditional fermentation process using the Artofex Dough Mixer. The recipe for the CBP and the fermented dough methods as well as a full report on the composite flour project are contained in Research Report No. 45 which is in press.

(b) *Production of Malt from Nigerian Cereal Grains*

The suitability of white and yellow varieties of Nigerian Guinea Corn (*Sorghum candatum*) for brewing European type beers was assessed by three parameters, in addition to earlier ones.

These other parameters were

- (1) the extract yield
- (2) the time of saccharification and
- (3) the time of filtration.

It was earlier reported that grains floored for six days at ambient temperature gave the highest reducing and non-reducing sugars (Jan-March Quarterly Progress Report 1972). This sample of sorghum malt was therefore used for a comparative study with commercial barley malt as standard. The latter was obtained from the West African Brewery Ltd., Abeokuta.

Using paper chromatography technique, the following sugar were identified from wort, prepared from white sorghum malt ; namely arabinose, glucose, fructose and maltose. Some other sugar spots could not be identified owing to a lack of authentic sugar standards. The standard Congress method of mashing malt was employed.

Results of analyses are tabulated below. In Table 1, white sorghum malt is evaluated with reference to barley malt. The poor quality of the locally malted white sorghum, as indicated in Table 1 led to the mixing of these two malts in varying proportions as outlined in Table 2. These mixtures were also evaluated using the same parameters.

TABLE 1

ANALYSES OF WHITE SORGHUM AND BARLEY MALTS

Malt	% Extract Yield(Dry)	Saccharification Time (min.)	Filtration Time (min.)
Barley	78.50	< 10	< 60
White Sorghum	35.50	Nil	> 180

TABLE 2

ANALYSES OF MIXTURES OF BARLEY AND WHITE SORGHUM MALTS

Barley : Sorghum (g)	% Extract Yield(Dry)	Saccharification Time (min.)	Filtration Time (min.)
50 : 0	76.5	< 10	< 60
25 : 25	66.5	Nil	70
20 : 30	59.3	Nil	90
15 : 35	52.2	Nil	> 180
10 : 40	49.8	Nil	180
5 : 45	47.5	Nil	> 180
0 : 50	40.5	Nil	> 180

These results show that even at 50 per cent dilution of commercial barley malt with white sorghum malt, poor yield, saccharification and filtration still resulted. It is recommended that flooring be done at a lower temperature (20°C) and then these experiments be repeated. This failing, an alternative will be to continue flooring at ambient temperature and then try lower proportions of sorghum malt.

(c) *Toxicological Studies on Soy-Ogi*

This report covers work carried out to study the effect of storage on Soy-ogi, a protein enriched product, developed and proposed for adoption, to alleviate the condition of malnutrition in Nigerian children.

The biological evaluation of the microtoxins that may be present naturally or as a result of contamination in the Soy-ogi stored for over 6-12 months was carried out on frogs. Frogs are simple animals which would easily and quickly exhibit deleterious effects of the microtoxins if present at a threshold level. The biochemical and pharmacological analysis of the extract were also carried out.

The alcoholic extracts of soy-ogi were obtained using the Soxhlet extraction procedure. The distillate was concentrated under vacuum and finally dialysed against water for 24 hours in cold (4°C). The procedure was repeated with other fresh samples to obtain enough dialysed precipitate. The dialysed sample was injected into the animals after 24 hours. The frogs were kept in a glass jar, half filled with water.

The motor function, swimming pattern and avoidance reactions were observed. After a test period of twenty days, the brain (neurons) activity, heart function and muscle tone were examined using the physiopolygraph equipment.

The frogs were in excellent health : The pharmacological tests carried out showed that the motor function, brain activity, swimming pattern and avoidance reactions were excellent. The physiopolygraph recordings of the brain cells (neurons), heart and muscle cells through the oscilloscope were normal. The histopathological examinations of organs such as the brain, liver, heart, kidney did not show any gross abnormality. The trypsin inhibitor and haemagglutinin activities could not be detected in the soy-ogi extract.

From the data obtained from the tests, there is no evidence to suggest any definitive toxic effect. Soy-ogi stored for a period of 6-12 months has not been contaminated.

(d) *Protein Enrichment of Gari*

Fortification trials were made with yeast protein, soya bean protein isolate and a mixture of yeast protein and soya-bean protein isolate and the results were compared. The results of the determination of protein content, colour and organoleptic quality of the fortified Gari are shown in Table 1.

TABLE I

TESTS ON FORTIFIED GARI

Fortificants	% Protein	Colour	Flavour	Taste
Control	Nil	Normal	Normal	Normal
Yeast protein	5.0	Slightly Dark	Normal	Normal
Soya bean Protein ..	5.0	Normal	Very Fair	Normal
Yeast protein + Soya Protein ..	10.0	Dark	Fair	Normal

Work is in progress to improve the colour and flavour of the product fortified with the mixture of yeast and soya bean protein isolate.

Work was also carried out on the toxicological evaluation of gari enriched with yeast protein from *Candida utilis*; and soya bean protein isolate. Solvent extraction of the possible toxicants and contaminants in the yeast protein and the soya bean protein isolate, was carried out, using the modified method of Ray (1969). The dialysate obtained was orally administered (200 mg/ml/rat) to groups of young growing rats. The extracts from raw as well as processed soya bean flour were similarly administered to other groups of rats for comparison and the rats were fed on commercial diet and water ad libitum. The results of these investigations are shown in Table 2.

1 Ray, P. K. (1969). J. Fd. Sc. Tech. 6, 207.

TABLE 2

EFFECTS OF MACROTOXICANTS ON YOUNG RATS

Source of Toxicants	Initial body weight (g)	Clinical Appearance	Mortality %	Average* change in body weight g + SD
1 Raw soya flour ..	25-30 ..	Fair to Normal Dry skin	50 ..	-3.5 ± 0.4
2 Processed soya flour	25-30 ..	Normal ..	20 ..	+4.8 ± 0.6
3 Yeast Protein ..	25-30 ..	Normal ..	10 ..	+5.2 ± 0.5
4 Soya Protein ..	25-30 ..	Normal ..	30 ..	+1.6 ± 0.3
5 Physiological saline	25-30 ..	Normal ..	10 ..	+5.5 ± 0.5

* The results are the mean of 10 rats per group measured after a period of 7 days.

The data presented in Table 2, indicate that the dialysate from yeast protein does not contain any toxic factor. The toxic and inhibitory effects of raw soya bean flour, are more pronounced when compared with those of rats fed on soya protein isolate. It appears that the toxic factors of raw soya beans were not completely removed from the protein isolate preparation. These factors are mainly trypsin inhibitors and haemagglutinins. The latter are more readily destroyed by moist heat than is the trypsin inhibitor.

(e) *Microbial flora of Nigerian Foods*

The following Nigerian food products were investigated.

(i) Soft drinks—Coca Cola and Fanta ;

(ii) Fresh palm wine.

(i) *Microbiological Analysis*

Two soft drinks Fanta and Coca Cola were examined for 'total plate count' (TPC), coliform enumeration and 'aerobic spore count' at 80°C. The tests for 'total plate count' and coliform bacteria were carried out with different diluents—distilled water, peptone water and phosphate buffer. The results (Table 3) show that there was more recovery of organisms when peptone water was used than with distilled water which in turn, gave greater yield than the phosphate buffer. No coliform bacteria were detected. The work on the cassava fermenting organisms is still at the initial stage.

TABLE 3

MICROBIOLOGICAL ANALYSIS OF FANTA AND COCA COLA

	Total Plate Count Colonies/ml			Aerobic Spore Count		Coliform Enumera- tion
	Distilled Water	Peptone Water	Phosphate buffer	At 80°C for 1 min.	At 100°C for 1 min.	
Coca Cola	1.5×10^4 ..	7.5×10^4 ..	1.5×10^3 ..	10	—	—
Fanta	.. 3.5×10^4 ..	4.5×10^4 ..	4.0×10^2 ..	10	—	—

Using the "Pour Plate Method", various microflora were isolated from fresh palmwine obtained from palm trees around the Institute. The pure colonies of the different flora were sub-cultured on agar slants. The results of the studies on the isolates are shown in Table 4. Work is in progress on the identification of the other unknown micro-organisms.

TABLE 4

MORPHOLOGICAL, COLONIAL AND BIOCHEMICAL DIAGNOSTIC
FEATURES OF PALMWINE MICROBIAL ISOLATES

Isolates	Colonial and morphological characteristics	Biochemical tests	Inference
CHARACTERISTIC			
I	Colonies on agar are soft, moist and cream coloured. Cells are round with budding.		<i>Saccharomyces cerevisiae</i>
II	Colonies on agar are transparent soft and whitish. Cells are cylindrical with rounded ends. Reproduction is by binary fission.	Decomposed L-malic acid in grape fruit juice at low PH value to alcohol	<i>Schizosaccharomyces pombe</i>
III	Colonies are round and pale yellow in colour. Conidia are produced in clusters on aerial hyphae	Reduce nitrates to nitrite. Growth on potato agar is cream coloured.	<i>Streptomyces sp.</i>
IV	Spreading, creamy and soft colonies. In young colonies there are long mycelial strands which break into short cylindrical spores		<i>Geotrichum sp.</i>
V	Small, round orange colonies. These are irregular in masses or in tetrads, in pairs or sometimes singly. These are grain positive.	Gives a positive catalase test. Do not liquefy gelatin slab; nitrate not reduced to nitrite	<i>Lactobacillus sp.</i>

VI.	Yellow colonies, cells long, slender, non-motile. They are grain positive	Do not reduce nitrates. Do not grow well in potato agar. Gelatin not liquefied	<i>Lactobacillus sp.</i>
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The identification of the organisms was based on the Bergey's "Manual of Determinative Bacteriology" which was used as a guide.

PRODUCTION OF SUITABLE STARCH FOR THE TEXTILE INDUSTRY

(a) *Effect of Preservative on the Resistance of Modified Cassava Starch Paste to Microbial attack*

For the Industrial evaluation of modified cassava starch produced at the Institute, samples of the starch were sent to some textile mills for testing under mill condition. Most of the mills which took part in the evaluation gave very satisfactory report on the starch but one of the mills commented on the susceptibility of the starch paste to microbial attack. Although this problem was not considered of major importance since it is envisaged that the paste will be used and kept at temperatures above 80°C where microbial action will be minimal and that the paste will be fully used up within twenty four hours of preparation, nevertheless it was considered judicious to investigate method of improving the resistance of the starch to microbial attack. The method investigated was the addition of preservatives to the starch in powder form. For any preservative to be suitable for use the following conditions must be satisfied :

- (1) It must not affect the colour of the starch ;
- (2) It must not degrade the starch ;
- (3) It must be cheap and readily available.

To samples of modified starch various preservatives were added using 10% preservative. The starch samples were then submitted to tests as in previous experiments (Annual Report of F.I.I.R.). Paste of each sample was also exposed in the laboratory and visual observation of changes made. Two modified starch samples and one unmodified starch sample to which no preservative was added were used as controls. A summary of the results is shown in Table 1.

The result suggests that Zinc Sulphate may serve as an effective preservative for modified starch against microbial attack, but the proportion of 10% added would appear to be high. Consequently, investigation was carried out to determine the optimum concentration of Zinc Sulphate required for effective preservation of the starch. Four samples of modified starch containing varying proportion of Zinc Sulphate (0.5%, 2.5%, 5% and 10%) were prepared. The samples were submitted to test as in previous experiments (see F.I.I.R. Annual Reports), using unmodified and modified starch samples to which no preservative was added as controls. A summary of the result is shown in the Figure 1 and Table II. The effective preservative power increases with proportion of Zinc Sulphate in the starch. The hot paste viscosity of the treated starch samples as compared with that of the modified control sample increases with increasing proportion of Zinc Sulphate up to 2.5% after which a decrease is observed. A decrease in the cold-paste viscosity of the treated samples is observed from the proportion of 2.5% Zinc Sulphate. This indicates chemical degradation of the starch from 2.5% concentration of Zinc Sulphate, and is confirmed by the high increase in the acidity of the starch samples.

Conclusion

Zinc Sulphate exhibits high degree of preservative power at concentrations above 5%. Some degree of preservation is exhibited up to 5% concentration. Degradation of the starch commences at concentration above 2.5%. Starch paste for sizing is usually utilized within 24 hours. Zinc Sulphate can therefore be used as preservative for starch for sizing at concentration up to 2.5%.

TABLE I
EFFECT OF PRESERVATIVES ON CASSAVA STARCH

Samples	1 $Bacl_3$ H_2SO_4 Hydrolysed	2 $Bacl_3$ HCl Hydrolysed	3 Control H_2SO_4	4 Control HCl	5 Control Unmodified	6 $ZnSO_4$ H_2SO_4 Hydrolysed	7 Na_2SO_3 HCl Hydrolysed	8 Na_2SO_3 H_2SO_4 Hydrolysed	9 ZnS^4 HC Hydrolysed
Colour (flour)	White	White	White	White	White	White	White	White	White
Moisture Content %	15.5	14.9	13.5	12.7	9.6	7.3	6.5	6.0	7.2
pH	7.6	7.6	9.4	9.3	5.6	6.4	8.7	8.8	6.3
Soluble Material %	4	5	1	1	—	2	2	6	3
Ash %	7	7	2	1	—	1	9	7	3
Gelatinization Point °C	71	70	68	69	66	67	70	69	65
Peak Viscosity (Heating)	150 (75°C)	260 (75°C)	140 (75°C)	180 (75°C)	740 (85°C)	320 (75°C)	50 (75°C)	150 (75°C)	320 (75°C)
Brab. Unit Appearance of Paste	Thin Uni-form gel	Thin Uni-form gel	Thin Uni-form gel	Thin Uni-form gel	Thick Uni-form gel	Thick Uni-form gel	Very Thin gel	Thin gel slightly cloudy	Thick Uni-form gel
Observation on Exposure	Slight mould formation slight discoloration and liquefaction	Slight mould formation slight discoloration	Complete liquefaction of the paste within 3 days	Complete liquefaction of paste within 3 days	Complete liquefaction of pastes within 3 days	No visible Change by 10th day	Slight mould formation slight discoloration no liquefaction	Complete liquefaction by 8th day	No visible change by No date

TABLE II
EFFECT OF ZINC SULPHATE ON CASSAVA STARCH

Samples	(Control) Untreated Modified	0.5% ZnSO ₄	2.5% ZnSO ₄	5% ZnSO ₄	10% ZnSO ₄	(Control) Untreated Unmodified
Colour (flour)	White	White	White	White	White	White
Moisture %	9.0	9.4	9.0	9.0	9.3	9.6
pH	4.9	5.8	5.5	5.1	5.5	5.6
Total Acidity %	0.108	0.244	1.432	3.87	6.624	—
Solute Material %	1.1	1.6	1.7	4.8	17.0	—
Gelatinization Point °C	65	65	66	66	67	67
Peak Viscosity (Heating) Brab. Unit.	360(95°C)	500(90°C)	400(90(85°C)	280(75°C)	210(75°C)	740(85°C)
Viscosity at 95°C	360	460	380	260	160	700
Peak Viscosity (Coolint) Brab. Unit.	620(37°C)	640(37°C)	520(37°C)	440(37°C)	310(37°C)	860(80-70°C)
Appearance of Paste	Thick Translucent gel	Thick Translucent gel	Slight Thin Translucent gel	Thin Translucent gel	Thin Translucent gel	Thick Translucent gel
Observation on exposure	Complete liquefaction within 3 days	Mould forma- tion by 3rd days no liquefaction	Mould forma- tion by 4th day no liquefaction	Mould forma- tion by 6th day no liquefaction	No Visible change by the 10th day	Complete liquefaction by the 3rd day

EXTRACTION AND PREPARATION OF NATURAL INDIGO FOR LOCAL DYEING

The development of an instant indigo dye from vegetable sources for traditional fabric dyeing was started in the last financial year.

Experiments were performed to establish the recipe and the operational procedure that would give the best levelling and depth of shade to the dyed fabric. Investigations revealed that best results were obtained with the following dye-recipe:

- 25 g/l Indigo leaves
- 15 g/l Sodium Hydrosulphite
- 5.5 g/l Sodium Hydroxide flakes

The operational processes involved in dyeing with indigo or say vat dyestuff include the solubilizing of the otherwise insoluble vat dyestuff by reduction in an alkaline medium ('vatting'), the dyeing, the fixation of the dye on the fabric by oxidation and after-treatment of the dyed fabric by soaping. The pre-treatment of the cotton fabric and these operational processes were explained in details in the last Quarterly Report of the 1972-73 financial year.

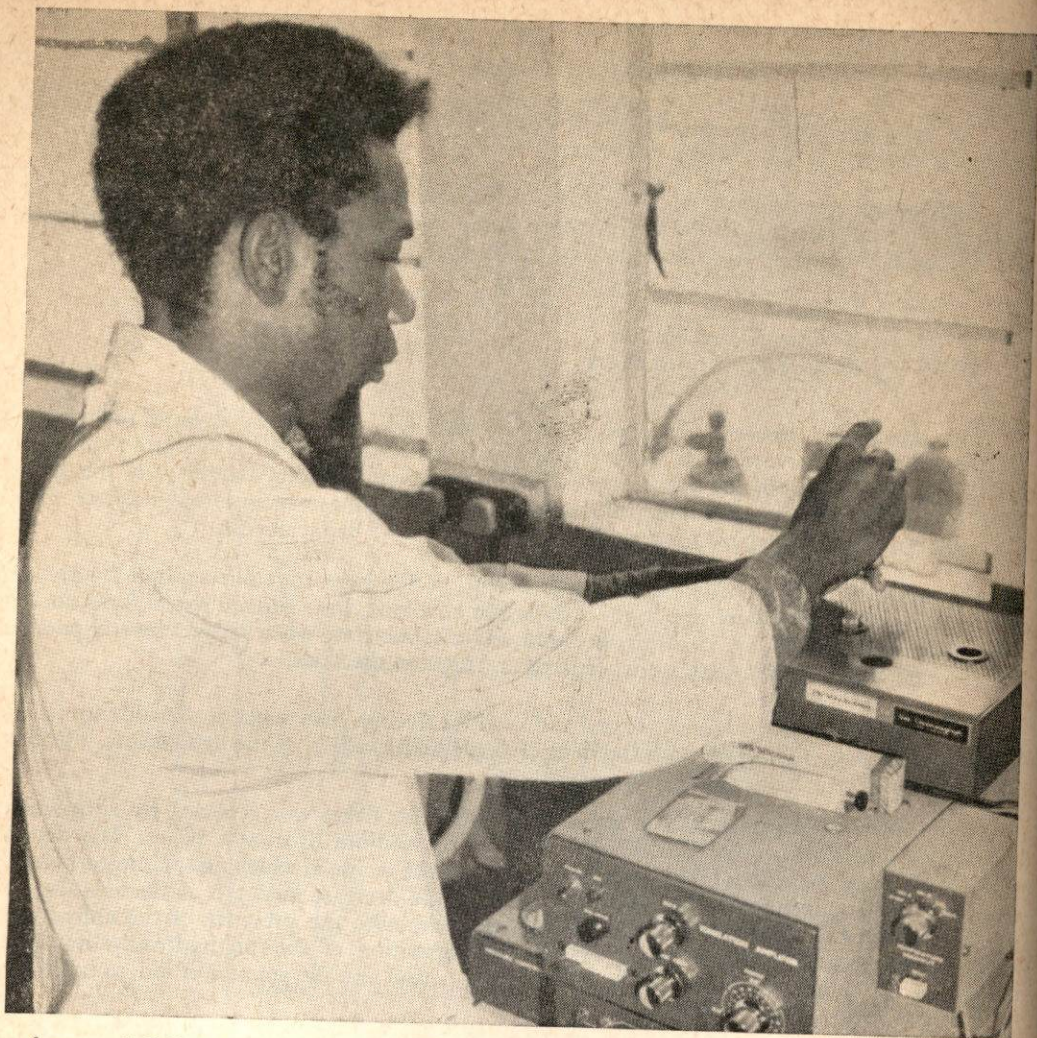
Sodium hydrosulphite is oxidatively and thermally decomposed, while sodium hydroxide is deliquescent. It is therefore important to ascertain how long, the recipe in parcel form can be maintained in condition, i.e. in a fully reduced and alkaline state when vatted. Several parcels of the recipe for 2-litre dye-bath were prepared and kept on the shelf.

A parcel was unsealed weekly, vatted and used for dyeing. The effect of shelf-life up to six weeks is so far not marked on both the dept of shade and levelling of the dyed fabric. Further observations over a longer period is continuing.

In another investigation, part of the sodium hydroxide flakes was replaced by anhydrous sodium carbonate to prevent the deliquescence of the sodium hydroxide flakes. The depth of shade obtained was not as high as that obtained from the recipe in which no sodium carbonate was incorporated. It is still to be confirmed whether the decrease in depth of shade is due to the decrease in the concentration of sodium hydroxide or to the presence of the anhydrous sodium carbonate. Determination of rate of decomposition of sodium hydrosulphite; the amount of the indigo in a vat throughout the dyeing period and the amount of indigo taken up by the fabric is also being carried out.

FLAVOURS AND ESSENCES

Following the adoption of the multi-disciplinary method of tackling research problems a task force was set up to deal specifically with flavours, essences and galenicals. It was thought worthwhile to investigate and characterise the active principles of the natural flavours of some local foodstuffs. The Federal Institute of Industrial Research (F.I.I.R.) has earned a good reputation for its work on the mechanised production of gari from cassava. Gari is also produced locally, mostly by the wives of farmers, in many of the rural areas of the country. The production methods of the local people vary from place to place so that the quality of the gari depends to a large extent on the producers. Consequently it was decided to investigate and characterise, first and foremost, the flavour of gari partly as a means of quality control and also as a way of enhancing (or at least maintaining) its organoleptic properties, now that it is produced mechanically on a large scale. In order to have consistent results, the gari produced at Federal Institute of Industrial Research was selected for the experimentations.



A research Officer analysing Volatile Compounds with the aid of x gas-liquid Chromatograph

Gari is processed from cassava (*Manihot utilisima*) tuber. The tuber is washed with water, peeled and grated to give cassava mash which is allowed to ferment (jute bags locally method) or aluminium tanks (F.I.I.R. method) for about four days. The fermentation time may be shortened to one day by seeding a fresh mash with four day old cassava liquor (Collard and Levi 1959). The fermented mash is centrifuged to about 50 % moisture content and passed into a granulator which breaks it into fine particles and removes the fibres. The granulated mash is passed into a rotating dryer having an average surface temperature of 120°C. Here, the mash is partially gelatinised and then dried. The final product is known as "GARI", and it is the main source of carbohydrate of the dietary system in Nigeria.

The biochemical reactions which give rise to the production of compounds that constitute the flavour of *gari*, are believed to take place mainly during the fermentation of cassava mash. Collard and Levi (1959) regarded the fermentation of cassava mash as being a two-stage process. The first stage results in the production of organic acids due to the attack of "*Corynebacterium Manihot*" micro-organisms on the starch of the mash. The acids cause a lowering of the pH of the mash and hence the spontaneous hydrolysis of the cyanogenic glucoside leading to the liberation of gaseous hydrocyanic acid. The second stage sets in with increase of organic acid content which favours the growth of "*Geotrichum Candida*" micro-organisms that produce a variety of carbonyl compounds—aldehydes, and esters mainly. The organic acid, esters aldehydes are believed to be responsible for the characteristic flavour of *gari*.

In some earlier work, Collard and Levi (1959) identified lactic acid while Akinrele (1964)' apart from confirming the presence of this acid, went further to identify formic and gallic acids in the fermenting cassava mash. Apart from advancing the qualitative determination of the flavours of *gari*, the present work also aims at quantifying the constituents of *gari* flavour. In this type of study, very small quantities of pure compounds are often involved and so much reliance is being placed on the use of

- (i) thin-layer and
- (ii) gas-liquid chromatography as well as
- (iii) infrared spectrophotometry.

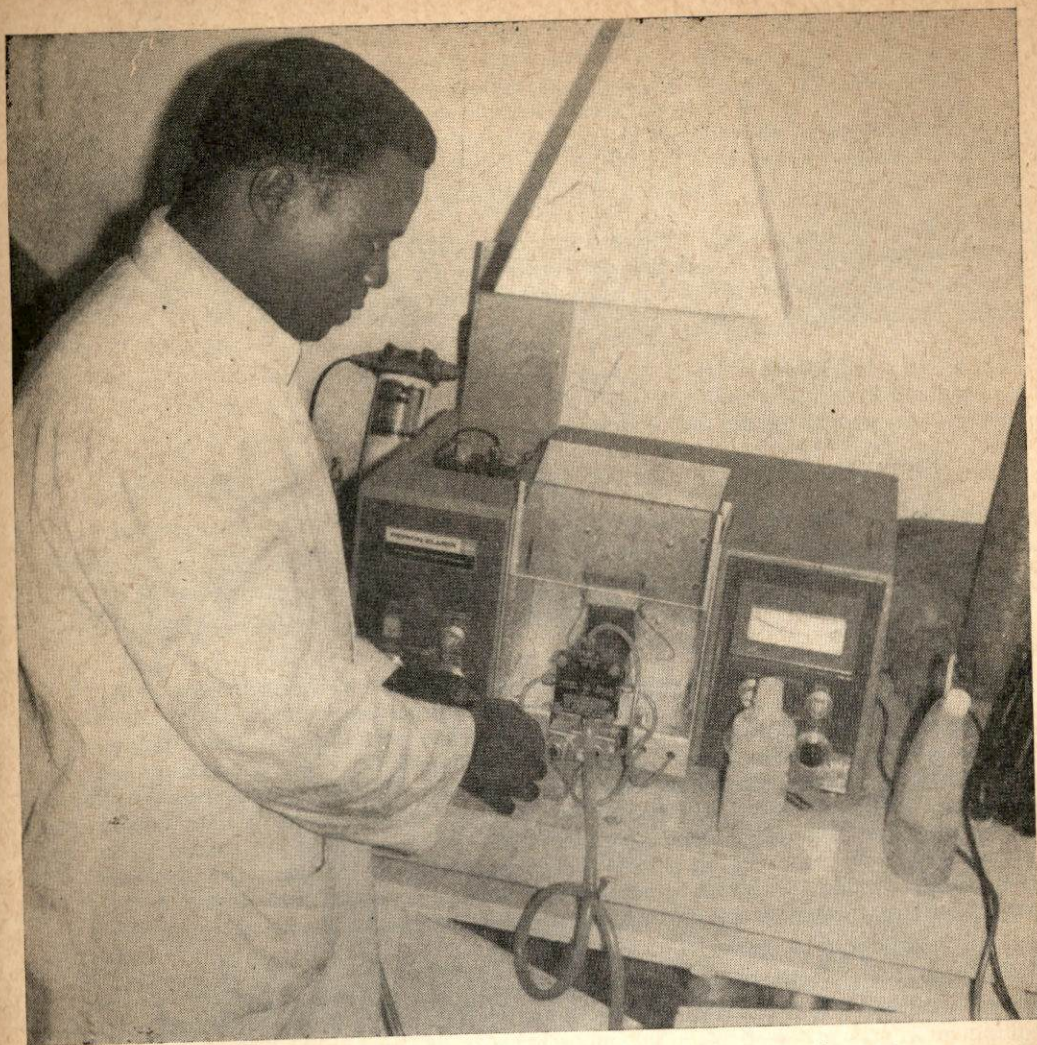
The important aspects of the work done so far are now reported briefly without emphasis on negative results.

Fresh samples of *gari* were dry-distilled under partial vacuum. The volatile constituent were condensed through traps in an ice-salt mixture. The condensate had only a faint aroma of *gari* while the bulk of the aroma was in the residue left in the distillation flask. The refractive index of the condensate at 24°C was 1.341 ; thus indicating it as mainly water. It was therefore decided to extract the *gari* organic solvents in a soxhlet extractor.

More samples of fresh *gari* were extracted respectively with either, 70% aqueous ethanol and methanol. The alcohol extracts were found to be very rich in *gari* aroma. Each extract was concentrated in a rota-vapor. White crystalline compounds that were precipitated from the concentrated extracts were re-crystallised from methanolic-ether solution. By using melting-point determination coupled with comparative thin-layer chromatography with authentic specimens, succinic acid (m.p. 184°C.) and dl-arabinose (m.p. 164°C.) were identified respectively from the ether and aqueous ethanol extracts. An unidentified crystalline compound (m.p. greater than 340°C.) separated out of the methanol extract. Further work on this will be reported later.



Nigerian woods' pulping characteristics being Investigated in the institute's pulp and paper labora tory



An analytical chemist operating the atomic absorption spectrophotometer

Other compounds identified from the extracts are : acetic, propionic and butyric acids (from the ether extract) ; lactic and succinic acids (from the alcoholic extracts). A preparative thin-layer-chromatography of the methanol extract was done, using a mixture of ethanol, ammonia and water (97 : 1 : 2) as the developing solvent and bromocresol purple as the indicator. Two major bands of Rf values 0.56 and 0.88 respectively were obtained. The band having Rf value 0.56 was found to be very rich in gari aroma. Efforts are now being concentrated on eluting the compounds of this band and identifying them by gas-liquid-chromatography.

In order to obtain a reasonable quantity of material to work with, more fresh samples of gari will henceforth be extracted first with ether in order to remove the acids before extracting the residue with aqueous alcohol as it has now been discovered that the aroma of gari is contained mainly in the alcoholic extract.

UTILISATION OF LOCAL VEGETABLE OILS AND OILSEEDS

(a) COSMETIC CREAM

(i) 'Nico' cream continued to occupy a greater part of our time. Further refinement of the skin cream (Nico Cream) from cocoa butter and palm kernel oil was carried out with a view to obtaining (1) a satisfactory texture (2) a whiter cream and (3) an acceptable and satisfactory perfume.

This period saw the introduction of a three-roll mill on the process line as a result of which a better consistency was obtained. Six different types of perfumes obtained from two different companies from Europe were tried in the cream and later sent out for acceptability test. The two most favourable perfumes selected were purchased in slightly larger quantities and subjected to further tests. The introduction of a whitener resulted in a slightly whiter cream. Further tests carried out have shown that it is not absolutely necessary to include the whitener in the formula, hence its use was dropped in latter experiments. A large number of jars of this cream have been prepared and have been sent out to various classes of people for acceptability and market evaluation. Results coming in so far are favourable and promising. Meanwhile arrangements are under-way to purchase necessary equipment and reagents for semi-pilot plant scale production.

(ii) *Cream from Cocoa Butter*—A satisfactory formula has been evolved for varnishing and emolient creams with cocoa butter and palm kernel oil as the main ingredients. A deodoriser for palm kernel oil and cocoa butter was constructed and it is working efficiently. With the equipment as presently available in the pilot plant only small quantities of the face creams could be manufactured. These samples have been handed over to the Industrial Analysis Division for carrying out market surveys. Trials at atmospheric pressure with the injection of steam to prepare fatty acids from cocoa butter have not been successful.

(iii) Using the formula for the Nico Cream but replacing the cocoa fat with shea fat an equally good skin cream was obtained.

(b) AVOCADO PEER

Both the skin and the edible portion of the Avocado Pear were dehydrated, cut into small pieces and separately extracted with ether. Gas liquid chromatography of the fatty acids and methyl esters from the oils was carried out. Experiments showed that oils obtained from both the skin and the edible portion of the Avocado Pear contain the same fatty acids in the same proportion. These acids have been shown to be palmitic (23.8%), palmitoleic (11.8%), oleic (57.0%) and linoleic (7.3%) acids. A trace amount of stearic acid was also obtained.

Methanol extraction of the defatted portion of the edible portions yielded a white crystalline compound m.p. 181. Infrared spectrum of this compound showed that it is an hydroxy aliphatic compound. The filtrate gave a positive test for saponin. Investigation continues.

(c) SHEANUTS

Samples of freshly harvested and one year-old sheanuts were separately ground and extracted with ether. Free fatty acid, acid value and iodine values were determined on each oil sample. Investigation showed that the old sample has higher free fatty acid value (17.8) and acid value (35.7) than the new sample which has 7.2 and 14.4 respectively; while the iodine value of the old sample (51.4) is smaller than that of the new sample (98.7). These results show that the old sample must have suffered some deterioration as a result of the autoxidation of the unsaturated fatty acids to produce some free fatty acids. Composition bb g-l-c. showed that the oil contained palmitic (4.5%), stearic (39.6%), oleic (47.0%), and linoleic (8.9%) acids.

Methanol extraction of the defatted sheanut powder yielded a brown resinous substance which gave a positive test for saponin. Investigation to find the nature of the saponin continues. Meanwhile defatted sheanut powder has been fed to rabbits without any adverse effect. Investigation continues.

INDUSTRIAL EVALUATION OF NIGERIAN CLAYS

Investigation on the Jos Kaolin as potential refractory material is in progress. The preliminary test being carried out involves a special heat treatment of the refined raw material followed by particle size grading into medium and coarse grains. The raw sample consisting of fine grains and the medium and large grains were mixed in definite proportions. The sample was pelleted at a known pressure P and fired at a defined temperature $T = 1350^{\circ}\text{C}$ in a muffle furnace. Porosity and density of the fired material were determined. The graph of porosity P as a function of pelleting P was plotted (see graph). A straight line was obtained, indicating a linear relationship between porosity and the pelleting pressure. The effect of heat treatment on the formulated "refractory material" is also being studied. Results so far obtained indicate that prolonged heating of the material at constant temperature leads to a denser and therefore less porous material, provided the pelleting pressure and moisture content had been kept constant.

PROCESS ENGINEERING

MECHANICAL PEELING OF CASSAVA ROOTS

(a) *Study of the Hydration Properties of the Cassava root*

In as much as peeling is a time consuming and labour intensive process, trials were made to see whether the hydration properties of the cassava root could be used for removing the peel. It was learnt that in the East-Central State peeling is done by squeezing the fleshy inside of the cassava root out of the peel, which has been loosened by three days of 'Soaking in water. Experiments were designed to simulate this in the laboratory to determine how far this could be practised industrially. It was found that the cassava roots do not soften enough on soaking for the meat to be extruded. Even after soaking for more than seven days the softening of the root was most probably due to microbial spoilage than water absorption because the gari from the soft roots was not acceptable. This method therefore does not offer much scope for peeling the cassava root.

(b) *Trials on the Mechanical Peeler*

During the year, a mechanical peeler was installed for the peeling of cassava. Extensive trials were conducted and the parameters for the ideal peeling of the cassava root by the machine were established. It was found that the peeler needs water in the ratio of 1 : 1 to have efficient peeling. The water which contains the peel presented a disposal problem. This problem will be tackled in the following year. A mechanical peeler of this type could work efficiently only if several accessories such as conveyor belts were used in conjunction with it. In view of the capital cost that would be involved in setting up such equipment comparative studies were made between hand peeling and machine peeling. Data collected is not sufficient to arrive at any conclusion. This study will be continued in the following year.

(c) *Trials on the Hydraulic Press*

The hydraulic press for dewatering the cassava mash was installed during the year. Trials were conducted on its efficiency as compared with the centrifuge which has been in use so far. No conclusive results have as yet been obtained.

2. PILOT COMMERCIAL PRODUCTION

(a) *Mechanised production of Gari*

A total of 127 tons of cassava were produced giving a yield of about 20 per cent. Some of the problems encountered during production were the frequent power failures, the break-down of some of the equipment like the gearbox of garifier, the centrifuge, grater, etc. These resulted in the low yield of 20 per cent as compared to the expected yield of 25 per cent. All the parts of the equipment which broke down have been repaired satisfactorily and the plant is now in operation. A standby generator has been recommended to help prevent losses caused by power failures.

Sales of Products

The demand for gari has always been more than what we have been able to produce and as such there has been no difficulty in clearing stocks. However, a complete reappraisal of all the costing is being made to see whether any reduction in the sale price can be effected. Consumers have been very much satisfied with the quality of the product.

(b) *Soy-Ogi Production*

Small-scale production of Soy-Ogi on the mini spray dryer was continued for some part of the year before there was a break-down in the dryer. The faulty spare part has since been ordered and received. During the year, the larger 3000 kg/day Niro Atomiser Spray-dryer was installed and commissioned. Preliminary results show that the spray-dryer operated well at the expected plant capacity of over 200 kg water evaporation/hr. It is hoped that a continuous Soy-Ogi production will soon be started under a streamlined process flowline. This should enable a further reappraisal of the technical and economic feasibility of the process as well as provide product for further nutritional, organoleptic and toxicological evaluations.

GENERAL ENGINEERING SERVICES

During the period under review, most of the major jobs outstanding from the latter part of the year were completed.

The 3 ton-a-day capacity dry product Niro Atomizer spray dryer which was purchased during the 1st quarter of the year has now been installed and commissioned. Apart from minor technical problems arising as a result of frequent power failure, the dryer has been performing satisfactorily.

The Cereal testing laboratory has gone into full service with the final solution of the electrical problems that the installation of equipment presented.

The transfer of the pulping laboratory from the pilot plant to Room 5 in the main laboratory has now been completed after the initial delays caused by the breakdown of the air-conditioning plant.

The (10+98) PABX system recently installed in the Institute is now operational to its full capacity with the provision of additional seven lines by the P and T. Other projects, which were in various stages of execution during the last two quarters of the year under review and which have now been completed include the construction of a chemical engineering laboratory in the Pilot Plant, the conversion of the old store house into Chalets and the installation of additional equipment on the gari plant in the pilot plant.

The technical assistance involving the drying of pepper for Cadbury Nigeria Ltd. has been discontinued following Cadbury's recent acquisition of a dryer.

PART THREE—TECHNICAL ASSISTANCE

GENERAL TESTING ANALYSIS

During the period under review chemical analyses were carried out on 62 samples including 22 samples of water, 17 samples of laundry soaps, 10 samples of toilet soaps, 5 samples of detergents and ceramic materials.

The samples were sent by Government Departments, Industries and Individuals requesting for specific tests to be carried out. Instrumental and classical methods of analysis were used.

Due to circumstances beyond our control the analytical work on detergents was not completed. The following lists show the bodies that requested for technical assistance :—

GOVERNMENT DEPARTMENTS

1. Four samples of laundry soaps were analysed for the Director of Prisons, Federal Prisons Department, Lagos.
2. Three samples of laundry soaps were analysed for the Ports Manager, Nigerian Ports Authority, Lagos.
3. Ten samples of toilet soaps and six samples of laundry soaps were analysed for the Nigerian Standards Organisation, Lagos.
4. One sample of water each was analysed for the Ministry of Agriculture and Natural Resources, Lagos State and the Federal Ministry of Trade (Bulk Purchasing Unit), Lagos.
5. Fourteen samples of clays were tested for their suitability for the Ceramic Industry.
6. A sample of ceramic material sent from Ondo Division in the Western State was found to contain a substantial proportion of the mineral pyrite, FeS_2 .
7. A sample of mineral sent by the Nigerian Steel Development Authority was tested and found not be graphite as thought by the senders. Preliminary tests, indicate that it could be Ilmenite, FeTiO_3 . The presence of Iron, Fe (about 4 per cent) has been established.
8. A comparative test was carried out on a rubber solution submitted by the Director of Industrial Development Centre, Owerri, East-Central State, to determine the suitability of the rubber solution for mending bicycle tubes.
9. A bottle of Scotsmea wine was analysed for the Director of Customs, Board of Customs and Excise, Lagos for alcoholic content and proof spirit.
10. Two samples of clay materials from East Central States, Enugu, were analysed for Iron, aluminium, and silica contents.
11. Seven samples of blankets submitted by the Director of Prisons, Federal Prisons Department, Lagos were analysed for quality.
12. Two samples of rain-coats submitted by the Director of Prisons, Federal Prisons Department, Lagos were analysed for quality.
13. Two samples of metallised fabric submitted by the Board of Customs and Excise were analysed for the proportion of metallised yarn.

14. Twelve samples of locally made dyed and printed fabrics submitted by the Nigerian Standards Organization were tested for colour fastness to washing with six different types of laundry soaps and five detergents.
15. A survey to establish the need for future investments and policy considerations for selected areas within Lagos State was completed.
16. At the request of the North-Central State Government, an extensive methodology for a feasibility study for tomato canning was prepared and forwarded to the government.

INDUSTRIAL ESTABLISHMENTS

1. Two samples of soap were analysed for the Managing Director of JOD Group (Nigeria) Limited, Surulere and one sample analysed for the Managing Director, Luthony International Limited, Ikeja.
2. Twelve samples of water were analysed for Mr E. O. Fasehun a representative of an oil exploring company in Port Harcourt.
3. Seven samples of water were analysed for Afprint (Nigeria) Limited, Isolo Road, Lagos.
4. One sample of water was analysed for Messrs Melbray Print and Packaging (Nigeria) Limited, Ilupeju Industrial Estate, Lagos.
5. Ceramic samples were analysed for Fichware and Wamac Ceramic Works at Ilupeju, Lagos.
6. Two samples of Khaki drills submitted by Messrs M. K. Ahama and Company were analysed for quality.
7. A management consulting assignment, primarily dealing with production scheduling and inventory problems, was undertaken for a small industry in the Ikeja area.
8. Private Entrepreneurs :
 - (ii) Consulting services were provided for a potential Entrepreneur who is interested in the establishment of a coconut-based industry.

PART FOUR

STAFF SEMINARS (1972-73)

The series of senior Staff Seminars for the year under review started earnestly during the first week of the year. But in order to give officers ample time to concentrate on their projects and prepare papers on them, the frequency of Seminars was reduced from bi-weekly to monthly during the first quarter and finally suspended in the two middle quarters (July-December). The series however resumed in the last quarter of the year with officers speaking on different topics as shown below :

<i>Name of Speaker</i>	<i>Topic</i>	<i>Date</i>
Mr J. A. Dina	Practical approach to malt production from Nigerian cereal grains	10-4-72
Mr S. C. O. Onyekwelu ..	Elements of multi-component distillation ..	6-5-72
Mr T. A. B. Faleye ..	Development of Skin Cream (cosmetics) from Cocoa butter/palm kernel oil at F.I.I.R., Oshodi : its problems and apparent solution.	17-2-73
Mr A. W. James	Composite flours for the baking industries. ..	10-3-73
Mrs B. L. Ariyo	Library Services and documentation work at F.I.I.R.	17-3-73
Dr S. I. Ahonkhai	Investigation and characterisation of natural and derived flavour essences of industrial interest.	31-3-73
Mr J. O. Alokwen	Pulping trials on selected Nigerian plant materials.	

(a) COMPOSITE FLOURS FOR THE BAKING INDUSTRIES

by A. W. JAMES

The tendency to eat bread is increasing among populations in many parts of the world where formerly bread was not an item of the daily diet. Probably the most significant cause for this change in eating habits is the urbanisation of communities and the convenience factor that bread offers to factory and office workers and to the busy housewife.

At a recent meeting of an International Study Group on composite flours, Mr Diallo the Nier representative said "The reasons for the preference for wheat products and rice have been analysed with the help of information obtained from several surveys. They lead to the conclusion that Nigerian women are responsible for this preference, as they are anxious at all costs to avoid the labour of pounding and preparing food."

From the nutritional point of view bread is a valuable food offering the opportunity of presenting a number of important nutrients in a well balanced combination, in a directly consumable and digestible form.

A significant feature of bread lies in the possibility to make bread nutritionally even more valuable by enrichment with additional protein concentrates like dry milk, soya or groundnut flours as well as with amino acid, vitamins and minerals, if these are deficient in a local diet.

Apart from the convenience aspect, there is no doubt that no matter what background people have the majority accept bread as a pleasant food and an acceptable alternative to their normal staple. That of course is not to say that bread will deprive the Irish of their potato or you of your yam, its just another alternative to the more sophisticated palate. Therefore I see no reason to discourage the consumption of bread provided from a National point of view you afford to eat it.

The reverse side of the picture, however is the necessity of increasing imports of wheat and wheat flours as most of the developing countries for reasons of climatic and soil condition cannot grow wheat, or if they do, domestic wheat production is not sufficient to meet the increasing demand. The exceptions being where there is a temperate zone caused by high latitude or high altitude or both—examples are Mexico, Northern India, and parts of Eastern Africa.

At present wheat importations into Nigeria stand at about ₦17 million and are increasing at the rate of about 15 per cent per annum. With a quickly increasing population and affluence this percentage increase is bound to rise.

The level up to which bread consumption may increase in Nigeria is difficult to anticipate. Where the level of bread consumption will lie in a remote future depends on a number of calculable factors. Perhaps the only way we can assess the possible evolution in this respect is calculating the bread consumption for the event of it reaching the level of bread consumed in those countries where bread has been a staple for centuries.

In Europe bread consumption varies considerably from country to country but lies within the range of 100 lb-300 lb per head annually. Now if we look at the figure for Nigeria you will see it is less than 9lb per head.

Here, the demand for bread is not new and has been increasing for many years. It has been estimated that between 1940-60 there was a 19-fold increase in bread consumption and since that time it has doubled again. Therefore I see no reason why the trend should alter, in fact in a recent publication by the Federal Department of Agriculture entitled "A Quantitative Analysis of Food Requirement, Supplies and Demands in Nigeria 1968-85" it predicts that wheat requirement will treble by 1985.

Now is there any hope that Nigeria can grow her own wheat, to either maintain import at the present level or even reduce their importation. In Northern Nigeria a type of wheat resembling durum wheat has been traditionally cultivated. This is a type of wheat suitable for making Pasta but not normally used for bread and is used in local food preparations.

In 1959 the Government of Nigeria decided to develop irrigation schemes in the North or the country between latitudes 12-14°N for cultivation of wheat which it was hoped would be suitable for bread-making flours. The wheat crop is normally planted in November or December and is harvested in February or March. During this period the Harmattan blows from the N.E. and this coupled with a very low humidity can lower the surface temperature of wet earth to below 40°F.

The Institute of Agricultural Research at Samaru say that in the long term the development of irrigated schemes presently under consideration could provide in the region of half a million acres of potential wheat land. This area could meet Nigeria's wheat need well into the future.

The work is still in its infancy and despite a number of setbacks fairly promising results are being obtained. However it is bound to be several more years before the impact of these schemes begins to be felt. Plans are already under-way to establish a Flour Mill for the production of bread-making flour at Kano. This is a ₦2,000,000 scheme jointly sponsored by the Kano State Government and the Nigerian Flour Mills.

I have spoken a lot about wheat and the difficulty of obtaining it, but I am sure to many people who are not familiar with the food industry a question arises in their mind which is basic to our understanding of the problem—the question is why do we need wheat flour to make bread and why can't we use something else?

The answer is that wheat is a unique cereal or very nearly so. Its uniqueness stems from its proteins, from the insoluble proteins which when wetted and agitated come together to form a rubbery mass which we call gluten. (Sample) gluten forms the skeleton for the structure of bread and gives to breads dough the elastic property and the ability to retain the gas produced by yeast cells during their reproduction cycle. This quality of gas retention enables the dough to rise during fermentation and proof. During baking the protein network sets or coagulates and forms the structure ; the honeycombe texture that we expect to find in bread.

So gluten is a basic requirement for a bread dough and until such times as an artificial gluten is available wheat flour will remain the basis of conventional bread that we have come to accept. Laboratories in Britain, U.S.A. and the Netherland are concentrating on finding suitable gluten substitute. This of course is essentially an exercise in protein chemistry and as Dr Asselberge, Chief of the Food and Agricultural Industries Service of F.A.O., recently said that he considered this research similar to the research that led to the development of synthetic fibres or synthetic rubber. There is obviously a similarity, perhaps in reverse order. When countries were out off from their traditional suppliers of natural rubber or fibre, synthetic substitutes were developed in a very short period of time. It is now the developing countries which are in need of a synthetic substitute for gluten since they are unable to produce sufficient wheat. (This however is not my subject and I leave this work to the protein chemists).

Returning then to wheat flour, provided it has a fairly high level of gluten forming protein of good quality, it is possible to blend into wheat flour other starchy materials and these are then carried by the wheat flour gluten in other words they reduce the percentage of gluten in the flour mixture and can be termed wheat flour extenders and the resultant mixture is now referred to as a composite flour.

What happens when we extend the wheat flour gluten in this way is fairly obvious, we reduce the ability of the flour to entrap the gas produced by the yeast which results in a reduction in the final loaf size or volume and tends to give the bread a more open texture. The bread also becomes a little more crumbly and some materials such as millet and soya will add their own flavour to the article. The composite flour project therefore is designed to establish the extent to which a particular wheat flour can be extended to maximize foreign exchange saving and minimize changes in final loaf quality.

Making bread by substituting part of the wheat rather than the whole is not a new idea and it is worthwhile to mention some of the efforts made in the past to make bread from what we now call "composite flour". These efforts have usually been made at times when wheat has been scarce. In ancient times, barley was the diluent most frequently used, and bread containing large amounts of barley was often the staple food of the poor in Britain. This situation continued

though to Medieval times. In Britain, barley, rye, oats and sometimes beans, were added to the wheat, for in most years wheat was too dear for the common people. By the end of the 19th century large quantities of wheat were being imported from North America into Britain, domestic supplies having become too small for the large and now mainly industrial population : scarcity came with the First World War when imports were drastically reduced. As in previous times of scarcity, it became necessary to put non-wheat materials into bread. Barley, which grows well in Britain and is grown on large scale for use in brewing, was again chosen as the principal diluent but occasionally potatoes, rye and maize were used. At first only five per cent of the diluent was added to the wheat but the quantity was gradually increased and by the end of that war, bread frequently contained some twenty per cent of non-wheat material and the wheat flour itself was at the 90 per cent extraction rate. Dilution with barley, potatoes, rye and maize, occurred throughout the embattled countries of Europe but as soon as the war was over dilution ceased and all-wheat bread was reintroduced.

It was not until the Second World War that dilution was reintroduced in Britain. Oats (up to 5 per cent), rye (up to 2.5 per cent) and barley (up to 10 per cent) were occasionally added.

Now the recent interest in Composite flours stems from the realisation that bread consumption is increasing in developing countries at a very fast rate indeed. According to a FAO WORLD survey the annual consumption per capita in West Africa for wheat increased from 2.8kg to 3.6kg between 1965-70 whereas the consumption of sorghum/millet decreased from 87.3kg to 73.5kg per capita during the same period. In quantity, the deficit in wheat (that is import less export) increased by 6.9 per cent for Asia, 11.5 per cent for Latin America and 12.3 per cent for Africa. The World market price for wheat decreased during this period thus limiting the effect of increasing imports. Nevertheless imports of wheat into developing countries from the main wheat exporter countries like U.S.A., Canada, Australia, Argentina and France, has created a serious balance of payment situation in many of the importing countries. FAO also felt that political disadvantages in addition to the economic problems are created by this increasing reliance on outside sources for such a basic foodstuff. We in Britain have come to accept this situation as inevitable and I would think that it is regarded as a normal part of world trade—that's not to say we would not be happy to grow our own wheat and save foreign exchange.

However it was these two considerations which prompted F.A.O. to form the Composite flour Project in 1964. Their first step was to update and co-ordinate work which had already been done. In 1965 FAO approached the Institute for Cereal Flour and Bread TNO in the Netherland to explore the possibilities of utilizing non-wheat flour in bread-making and other baked products. This work eventually led to a bilateral agreement between the government of Colombia and the Netherland to establish a field project at the Institute for Technological Research in Bogota to introduce Composite flour bread amongst the population of the city. The initial cost of this project as \$600.00. Several products have been introduced but the most successful has been bread made from a mixture of 70 per cent wheat flour 27 per cent rice flour and 3 per cent soya. Mr Sluimer who is the Project leader has recently reported that it has been proven possible to produce Colombian type bread from diluted flour containing 30 per cent non-wheat components, using mostly traditional fermentation bread-making procedures and that commercial bakers are able after brief instruction to produce good quality bread.

During the last decade a technological transformation has taken place in the British Bread Industry. This has been brought about by the introduction of a new bread-making technique—developed at the B.F.M.R.A. which has eliminated the need of traditional fermentation. You see fermentation is not just a means to produce carbon dioxide gas to make the dough rise, it facilitates a very complicated chemical change to take place within the protein of

gluten network. If you feel a bread dough immediately it is mixed you will notice it is tough and breaks short when stretched. If however you feel it again after the fermentation period you noticed a very marked change in its consistency—the dough will have become much more pliable and extensible and elastic when stretched. The dough in this condition is more able to be shaped and produce a regular texture in the crumb.

The new bread-making technique which incorporates amongst other features, intense mechanical agitation in special high speed machines, this enables conditioning of the protein to take place in a matter of minutes instead of hours.

There are many production advantages for this process including reduced production time and space, better control and higher bread yields due to reduced fermentation and evaporation losses. But one advantage which was not immediately obvious but is of particular significance to our Composite flour project is that it has been found that weaker flours than those traditionally used for making bread could be employed. This has resulted in Britain being able to use much larger percentages of home grown wheats in her wheat grist.

In 1967 FAO approached a British Soya Flour Manufacture, the British Arkady Company whose sister company produces the most popular of the new bread of high speed dough mixers—to look into the possibility of using this new bread-making technique in conjunction with blends of wheat flour and non-wheat flour. The result of their work clearly demonstrated the value of undertaking further trials adopting this technique.

As a consequence, the following year the Overseas Development Administration of the Foreign and Commonwealth Office set up a new test bakery in the Industrial Technology Department of the Tropical Products Institute at Culham near Oxford to expand on this work done by the British Arkady Company.

The Tropical Products Institute which is financed from British Aid Funds has a long history of Scientific Research in tropical countries and it was not long before the Institute was communicating with well over 30 countries in this field.

TPI have confirmed the advantages of the new bread-making technique with regards to Composite flours but at the same time it is realised that disadvantages also exist in countries where the baking industry is not so well mechanised. Therefore, although work has tended to concentrate upon the new bread-making techniques, traditional bread-making method are not overlooked.

One of TPI first contact on this subject was F.I.I.R. Oshodi this was perhaps a natural development of a long standing association between our Institutes.

Under the leadership of your Director this work has been proceeding at F.I.I.R. for some time. To further the work an agreement was reached between the Nigerian and British Government, to provide F.I.I.R. with bread-making, flour milling and cereal testing equipment. And under a T. A. agreement TPI have arranged for me to spend a year or so assisting this Institute to set-up the equipment to train staff and to give some guidance on the project.

Now if I may return again to the International scene for a few minutes. It will be seen that a great deal of interest has been created in this topic of Composite flours. FAO's next move was to encourage the establishment of a Study Group within the frame work of the International Association of Cereal Chemist's. The first meeting of this group took place in Vienna, Austria in May 1971. Participants included representatives of Institutes and industries from 17 countries and seven representatives of U.N. agencies. The second meeting was held last October in Bogota where 22 countries were represented. The next meeting will be in West Africa at Dakar, Senegal.

Now finally, I would like to turn my attention this morning to the Institute's Composite flour for bread-making programme, and to give you some idea of what has been achieved and where future developments may lie.

As I explained earlier, this Institute has in the past few years carried out a considerable amount of investigation into the use of locally grown non-wheat materials as extenders for wheat flour for bread-making. This work was carried out by Mr Shambe and Mrs Bamiro and not having bakery facilities on site made the work difficult; with the practical baking having to be done at Apapa in the laboratories of Nigerian Flour Mills. Despite this Mr Shambe did produce a lot of useful information and I understand he gave seminar on the subject. I only hope my talk today has not seemed too much of a repeat performance.

Some expansion of the Composite flour programme seemed advisable and the Institute wished to set up a facility which could, when necessary, offer advice and guidance to government departments on problems associated with the milling and baking industry. After consultations with the U.K. government the equipment which I have helped to instal was made available. This equipment includes a laboratory wheat flour mill and physical dough and flour testing apparatus, and also machines for experimental bread-making. I will not waste your time trying to describe this equipment, most of you will have seen it, and you know where it is, and you are welcome to come and talk about it at any time. The laboratory facility has enabled us to complete a very useful investigation into the use of Composite flours in Nigeria. I am not going to bore you with a lot of detail regarding bread-making recipes and methods. You will be able to read this information in the report which is being prepared at present.

Briefly however, our work to date indicates that the most promising material as a wheat flour extender is cassava starch and the most promising protein supplement source is soya bean flour. We have also shown that the wheat flour currently available to bakers in Nigeria will tolerate quite substantial dilution and still produce what ought to be considered as an acceptable loaf.

We must however, not look at these results through rose tinted-glasses. The basic fact is as I explained earlier if you dilute the wheat gluten forming proteins with starch or other proteins the net result is that you weaken the structure and reduce its ability to retain the gas produced by the yeast and the effect in the bread is manifested in reduced loaf size.

If you look back to the work Mr Shambe recorded, you will see that when he used a blend of 30 per cent cassava starch and 70 per cent wheat flour his loaf volume was reduced by 20 per cent on the control. I think our results now, show a reduction of about 15 per cent for a similar blend, still a significant reduction particularly as bakers tend to sell by volume and not by weight. Accompanying this reduction in loaf size is a coarsening of texture. The eating quality becomes shorter or more crumbly and the staling rate is increased. These then are the change which become more pronounced as dilution is increased. These changes in bread quality are not willingly accepted by the millers and bakers, and consumers will only accept them if they are not too obvious and if they are assured of the necessity to conserve foreign exchange and that there is no alternative. It is my opinion that no government would support such an unpopular step unless the necessity is real. In many countries, of course, this necessity is very real indeed and the Composite flour programme is designed to mitigate this adverse effect as much as possible.

It is my opinion that Composite flours cannot be introduced without government intervention in some ways. There are no technical advantages to offer either millers or bakers and no obvious advantages to the consumers unless you take the process further and offer a nutritionally improved loaf. The likelihood of a reduction in bread price to the consumer is remote. Even if

you make starch available at 25 pounds per ton cheaper than the wheat flour which means cassava starch must be available at £40 per ton and if it was agreed to accept a 70 per cent wheat flour and 30 per cent cassava starch blend, the maximum price reduction would be £7. 10s. (N15). This saving spread over 3,300 loaves which is the approximate yield of bread per ton of flour amounts to a little less than half a kobo per loaf. But we must not forget that the millers would say that their costs has been increased because production has been decreased and that they have been obliged to instal blending equipment for the mixture.

Bakers would say their production costs are also increased because their employees must work more carefully with the weaker flour. If they insist on giving the customer the same volume of bread then their yields, or number of loaves of bread produced per mixing would be reduced. Again, the increased staling rate may mean a higher number of bread returns to the bakery. Now I do not wish to paint too black a picture for Composite flour bread but these then are the realities which must be faced if the project is to be introduced to the industry.

It is not our responsibility to decide whether or not Nigeria should introduce Composite flours for its baking industry but it is the responsibility of an Institute such as this to keep the government policy-makers informed of such developments and that is why the Composite flour project has been so fully explored.

The object of all this is to try and reduce the importation of wheat, another perhaps more obvious and acceptable way is to try and use the local grown wheat. This is the work that we are now turning our attention to. The laboratory is at the present time examining samples from the Lake Chad schemes and it is hoped to expand this work to other government wheat breeding project in the North. In this way, government departments can be assured of a reliable and unbiased report on the progress on the schemes. Personally, I would consider this work to be potentially the most important project the section is likely to become involved with in the near future and the most rewarding in terms of National benefit.

I would like to think that the laboratory I have helped to establish would be the nucleus for a unit which actively involves itself with the problems, and has the interest at heart of one of the countries major industries which is in urgent need of assistance as it moves into a new era of modernization. Bakers are buying equipment from manufacturers who very often have only their own interest at heart and the baking industry needs the assistance and protection of a group of dedicated and qualified people who can advise and assist not only on the types and capacity of equipment but also on siting and installation problems. This is a valuable service and one which I think bakers would be prepared to pay for.

The laboratory can also turn its attention to the allied industries giving advices to manufacturers of raw-materials which range from bakery fat and yeasts to a whole range of bread improvers. For example bakers have complained to me that locally manufactured wax paper for bread wrapping does not seal properly. I am sure if approached in the right way, the manufacturers would co-operate and improve this aspect. Speaking from experience not only in Europe but in many parts of Africa, manufacturers in allied industries are usually only too pleased to work with somebody like ourselves who will act as unbiased intermediary between themselves and their customers. To do this work, of course, one must have a thorough knowledge of the problems of the industry you represent and at the same time have a sympathetic understanding of the manufacturers' problems.

Apart from this periphery assistance, bakers need more direct help to improve bread-making techniques and to introduce new ideas. They need advice on the control of moulds and general hygiene and smaller businesses often need help to control their costings and profits.

There is a wide range of advice to give to government departments regarding effective legislation. For example although there is a price control and weights and measures legislation for bread, these are not enforced. Perhaps you feel it is not necessary to control bread price and the market finds its own level, this may be so, but changes in weight are more subtle and not easily detected even by consumers aware of their rights. In a recent survey I have carried out, I have found that bread weights for the standard one shilling loaf vary from 315 grams to 596 grams. (454 gram. is the legal requirement for the one shilling loaf). I personally feel that consumer needs protection here, not that I would recommend the bakers are tied up in the centre of villages and pelted with bad eggs for selling under-weight bread, as was common practice in Europe until more recent times but enforceable legislation should be considered. It is interesting to note that even now the Weights and Measure's Officers do visit bakeries.

Finally, there is question of training bakery staff and perhaps the Institute could instigate thoughts along these lines and encourage and assist technical colleges to teach courses on bakery technology. These then are some of the problems facing the baking industry and problems which the section is now equipped to tackle.

(b) ELEMENTS OF MULTI-COMPONENT DISTILLATION

by S. C. O. ONYEKWELU

INTRODUCTION

The separation of mixtures of liquids into their component parts is one of the major processes of the chemical and petroleum industries and distillation is the most widely used method of achieving this end. When a liquid containing two or more components is heated to its boiling point, the composition of the vapour will normally be different from that of the liquid. It is this difference in composition of the two phases at equilibrium that forms the basis for a distillation process, and for this reason, a knowledge of the vapour-liquid equilibria is essential in the analytical treatment of a distillation problem. An important requirement of a distillation unit therefore is the provision of intimate contact between vapour and liquid streams so that equilibrium is approached.

VAPOUR-LIQUID EQUILIBRIA

The composition of the vapour in equilibrium with a liquid of given composition is determined experimentally using an equilibrium still. Let us consider the pressure-temperature—concentration phase diagram of only a binary homogeneous mixture A and B in which component A is more volatile, i.e. the vapour pressure of pure A at the same temperature is higher than that of pure B. The concentrations of the components in either phase is given by their mole fractions. We denote the mole fraction of A in the liquid phase by x and its corresponding equilibrium mole fraction in the vapour phase by y (vide diagram). The curve marked PA is the vapour-pressure curve of A lying entirely in the nearest composition plane at $x = 1.0$. The curve extends from its critical point CA to its triple point TA. Similarly curve PB is the vapour pressure of pure B, at $x = 0$. The liquid and vapour regions at compositions between $x = 0$ and 1.0 are separated by a double surface which extends from PA to PB. The shape of the double surface will be best understood by considering section at constant pressure.

CONSTANT-PRESSURE EQUILIBRIA

Consider a typical section at constant pressure (see diagram). The intersection of the double surface of fig. 1 with the constant pressure plane produces a looped curve without maxima or minima extending from the boiling point of pure B to that of pure A at the pressure in question. While the upper curve provides the temperature-vapour composition (t - y) relationship the lower that of the temperature-liquid (t - x) composition. The liquid and vapour mixtures being at equilibrium are at the same temperature and pressure throughout. Figure 2(b) shows the vapour-liquid equilibrium on a composition diagram (x vs. y). Since the vapour is richer in the more volatile substance, the curve lies above the 45° diagonal line which has been drawn for comparison.

RELATIVE VOLATILITY

The greater the distance between the equilibrium curve and the diagonal of fig 2b, the greater the difference in liquid and vapour compositions and the more readily is the separation by distillation made. The numerical measure of this separability is the relative volatility. This is a ratio of the concentration of components A and B in vapour phase to that in the Liquid phase.

$$W = \frac{y/(1-y)}{x(1-x)} = \frac{y(1-x)}{x(1-y)}$$

If W is unity, then no separation is possible. The larger the value of W above unity, the greater the degree of separability.

BASIC ASSUMPTIONS

Partial Pressures, Dalton's Raoult's and Henry's Laws

The partial pressure P_A of component A in a mixture of vapours is the pressure that would be exerted by component A at the same temperature if present in the same volumetric concentration as in the mixture by Dalton's Law of partial pressures.

$$P_T = P_A + P_B, \text{ i.e.}$$

the total pressure is equal to the summation of the partial pressures. Then in an ideal mixture the partial pressure is proportional to the mole fraction of the component in the vapour phase or

$$P_A = Y_A P_T$$

Henry's Law gives a simple relation for the partial pressure developed by a liquid solute A in a solvent liquid B or

$$P_A = K_X X_A$$

This holds only for dilute solutions.

Raoult's Law states that the partial pressure P_A of component A in a mixture is equal to the vapour pressure P_{AO} of pure A at the same temperature multiplied by its mole fraction X_A in the liquid phase.

$$P_A = P_A X_A$$

This is found true for high values of X_A . However, some hydrocarbons and organic isomers obey the law well.

DESIGN OF A FRACTIONATING COLUMN

If we ascertain the quantity and composition of the material to be distilled and the degree of separation we want accomplished then through material, enthalpy balances and the condition of physical equilibrium between the liquid and vapour, we can determine the number of plates/trays for the tray column and the height of packing for the packed column. This must be based on the optimal reflux ratio. For a two component system the graphical method of McCabe and Thiele is most popularly used. This will be demonstrated later.

TRAY SPACING

In the tray columns, the tray spacing (distance between trays) is usually chosen first on the basis of ease in construction, maintenance and cost and later checked for adequate insurance against flooding. Tray spacings are seldom below 6 inches while most commercial columns have a minimum of 18 inches spacing. In petroleum refining industries 18 to 20 inches is used for column diameters of up to 4ft.

COLUMN DIAMETER

To minimize entrainment of liquid in the vapour at high fluid flow rates, the tower diameter must be sufficiently large to handle the gas and liquid at reasonable velocities. The diameter is chosen by use of the volumetric gas flow rate and the superficial linear gas velocity V (Cu. ft. gas/sec. divided by empty tower cross-section, sq. ft.) obtained from the relation

$$V = K \frac{(S - S_u)^{\frac{1}{2}}}{S_u}$$

where S is the gas density lb./Cu. ft. based on the ideal-gas law and K is an empirical constant. The diameter of the column is read from graphs co-relating gas volumetric flow rate, tower diameter, and superficial gas velocities.

MULTISTAGE TRAY TOWERS

As we said earlier in the lecture the method of McCabe and Thiele for computing the number of plates required in a fractionator of a multi-stage type is most often used so we discuss it in some depth.

THEORETICAL STAGE OR TRAY

A Theoretical Stage or Tray is defined as one which gives rise to an effluent vapour in equilibrium with the liquid leaving the tray or stage. When the theoretical plates have been computed using McCabe and Thiele methods, the actual plates or trays needed are then found by using the tray efficiency.

METHOD OF MCCABE AND THIELE

The entire fractionating column is divided into two sections. The section containing the plates above the feed plate is called the *enrichment section* including the distillate condenser. The plates below the feed plate including the reboiler and bottoms product is called the *exhausting section*. By writing overall and component material balances for each section, operational equations for the section is developed.

ENRICHING SECTION

Consider fig. 4 which is a flow diagram representing the section of the column above the feed plate. The condenser is total and the reflux liquid is at its bubble point. y , x , are the mole fractions of the more volatile component in the vapour and liquid phases respectively while L , G , represent the moles of Liquid/vapour per hour per sq. ft. falling and rising respectively from/on, each tray. D is the moles of distillate per hour per sq. ft. withdrawn as product. If the principle of equimolal overflow is applied then the G and L values are constant for all plates in the section.

A total material balance for the envelope in figure 4 gives

$$G = L + D = D(R + 1) \quad \dots\dots\dots(1)$$

where R is the reflux ratio $\frac{L}{D}$

For component A we have

$$G y_{n+1} = L x_n + D \quad \times D \quad \dots\dots\dots(2)$$

From (1) and (2)

$$y_{n+1} = \frac{L}{D} x_n + \frac{D}{G} \dots\dots\dots(3)$$

or

$$y_{n+1} = \frac{R}{R+1} x_n + \frac{x_D}{R+1} \dots\dots\dots(4)$$

This is the equation of a straight line on x, y co-ordinates fig (4b) of slope $L/G = \frac{R}{R+1}$ and with an intercept of $\frac{x_D}{R+1}$ on y axis. Therefore the point (O, X_D) is a known point on $R-1$

this line. Also if we put $x_n = x_D$ in equation (4) we have that $y = X_D = \frac{x_D}{R+1}$ which is a point on the 45° diagonal line already drawn. With these two points the line described by equation (4) is easily constructed. A stair case between the operating line and the equilibrium line is constructed starting from point T This gives the theoretical tray—concentration variation.

$$\left(\begin{matrix} x_D & x_D \\ D & D \end{matrix} \right)$$

It is assumed that the pressure is constant throughout the tower. As the staircase method cannot be carried beyond point P (vide fig. 4) we have to consider the exhausting section of the column.

EXHAUSTING SECTION

Assumptions—the reboiled vapour is in equilibrium with the residue. Consider fig. 5 where $\bar{L}, \bar{G}$ are liquid and vapour flow rates which are constant from the principle of equimolal over-flow but different from those of the enriching section. A total material balance gives

$$\bar{L} = \bar{G} + W \dots\dots\dots(1)$$

and for component A, $\frac{\bar{L}x_m}{L_x} = \frac{\bar{G}y_{m+1}}{G_y} + \frac{Wx_w}{W_x} \dots\dots\dots(2)$

combining equations (1) and (2) we have

$$y_{m+1} = \frac{\bar{L}}{\bar{G}} x_m - \frac{W}{\bar{G}} x_w \dots\dots\dots(3)$$

$$y_{m+1} = \frac{\bar{L}}{\bar{L} - W} x_m - \frac{W}{\bar{L} - W} x_w \dots\dots\dots(4)$$

This is again a straight line of slope $\frac{\bar{L}}{\bar{G}} = \frac{\bar{L}}{\bar{L} - W}$

passing through the point $x = y = x_w$ (when $x_m = y_{m+1} = x_w$)

since the reboiler vapour y_w in equation (4) is assumed in equilibrium with the residue x_w the

first stair case of the construction represents the reboiler. The limit of the steps is point T (fig. 5) on equilibrium curve.

FEED INTRODUCTION

In order to have a complete picture of what happens in a tray fractionating column, we consider the feed plate and the effect of the feed condition on the intersections of the operating equations of the enriching and exhausting sections.

Feed

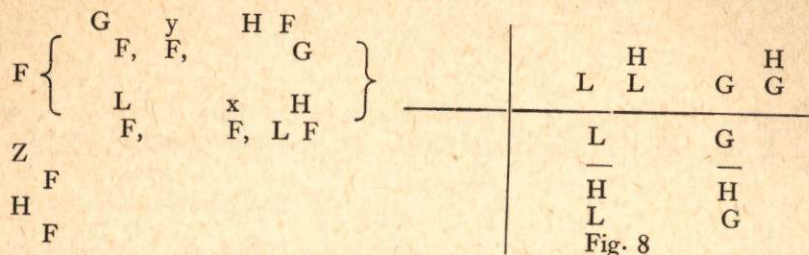


Fig. 8 shows a section of the column where the feed is introduced. The feed may come in, many conditions like sub-cooled liquid, saturated liquid, a saturated vapour, and superheated vapour. Material balance around the feed plate gives

$$F + L + \bar{G} = G + \bar{L} \quad (1)$$

and an enthalpy balance gives

$$FH_F + LH_L + \bar{GH}_G = GH_G + \bar{LH}_L \quad (2)$$

If we assume that the vapour and liquid in the column are saturated then, the molal enthalpies of the saturated vapours around the feed plate are the same or $H = H$ also the molal enthalpies

of the saturated liquids are equal or $H = H$ with this assumption, equation (2) becomes

$$(\bar{L} - L) H = (\bar{G} - G) H + FH_F \quad (3)$$

combining equations (1) and (3) we have

$$\frac{\bar{L} - L}{F} = \frac{H_G - H_F}{H_G - H_L} = q \text{ say} \quad (4)$$

if we combine equations (1) and (4) we have

$$\bar{G} - G = F(q - 1) \quad (5)$$

Equation (5) gives a convenient method for finding $\bar{G}$. Furthermore, if we combine the operating line equations for enriching and exhausting sections.

$$\bar{y}_G = \bar{L}x + \bar{D}x \quad \text{D} \quad \text{-----} \quad (6) \text{ (enriching section)}$$

$$\bar{y}_G = \bar{L}x - \bar{W}x \quad \text{W} \quad \text{-----} \quad (7) \text{ (exhausting section)}$$

If we subtract (6) from (7) we have

$$(\bar{G} - G)y = (\bar{L} - L)x - (\bar{W}x + \bar{D}x) \quad \text{W} \quad \text{D} \quad \text{-----} \quad (8)$$

By an overall material balance we get

$$\bar{F}Z = \bar{D}x + \bar{W}x \quad \text{D} \quad \text{W} \quad \text{-----} \quad (9)$$

A combination of equations (9), (5), (4) and (8) yields the equation

$$y = \frac{q}{q-1}x - \frac{Z}{F} \quad \text{F} \quad \text{-----} \quad (10)$$

which is the locus of intersection of operating lines.

This is a straight line of slope $\frac{q}{q-1}$ and intersects the 45° diagonal line at the point $x = y =$

Z_F . With the slope and the point (Z_F, Z_F) on the 45° diagonal known, the q line will be

established. Fig. (7) shows different q lines depending on the condition of the feed.

OPTIMUM REFLUX RATIO

The design of a fractionating column will not be complete without establishing the optimum reflux ratio for a required separation. The optimum reflux ratio is chosen in one of two ways (1) if the total cost $\mathcal{L}P_T$ per year which is the fixed cost $\mathcal{L}P_F$ plus operating costs $\mathcal{L}P_{op}$ per year can be expressed as an analytic function of reflux ratio R or $P = f(R)$, the first derivative $\frac{dP_T}{dR}$ is equated to zero and the value of R which minimizes P_T is chosen as the optimum

reflux ratio. The second method is graphical shown in fig. 7 where the total cost, the fixed cost, and operating costs are plotted as ordinates in the same graph against reflux ratio as abscissa. The point of intersection of the fixed and operating costs is taken as the optimum reflux ratio.

MODERN INDUSTRIAL PRACTICE IN MULTI-COMPONENT DISTILLATION CALCULATIONS

The graphical solution of McCabe and Thiele cannot be easily used to calculate the theoretical plates required for the separation of more than two component system. In the industry, especially petroleum industry where the crude oil may be a mixture of paraffin, olefin, aromatic hydrocarbons and sulphur, water, etc. and there is need to separate even the hydrocarbons into different fuel mixtures like, gasoline, kerosine, diesel, manual and computer trial and error methods are used.

COMPUTER SOLUTION

The advent of high speed computers made it possible for rigorous solution of multi-component distillation problems to be found, eliminating a whole lot of unnecessary assumptions made in manual calculations. In both the manual and computer techniques, the method of solution is by trial and error. In each case, sets of variables are tried until one is found which satisfies simultaneously all the equations describing the system.

STEADY STATE CONDITIONS

For the steady state conditions use is made of the law of conservation of mass.

Input—output = 0 —————(1)
in writing the material balance equations. The first law of thermodynamics in the form

$$\Delta H + \Delta K.E. + \Delta P.E. = Q - W_s \text{ —————(2)}$$

is used in writing the enthalpy balance equations. In addition to the laws of conservation of mass and energy, the condition of physical equilibrium of the liquid with its vapour is needed in describing completely the multi-component distillation system.

Henry's Law $y_i = K_{ix} \text{ —————(3)}$

is used to describe the condition of equilibrium for component i where K is a function of temperature, pressure and composition. Since the systems of equations resulting from the use of equations (1), (2) and (3) in solving multi-component distillation problems is often non-linear, analytic solution is not possible leaving us with the trial and error methods.

TRIAL AND ERROR PROCEDURES

Very many procedures have been evolved for solving trial and error problems. Among these are :—

- (1) Direct iteration method
- (2) Newton—Raphson method
- (3) Thiele and Geddes
- (4) Lewis and Matheson

DIRECT ITERATION

This is the most common trial and error approach. For manual calculations a set values are chosen and tried on the function to see if the conditions prescribed by the function are satisfied. If the conditions prescribed by the function are not satisfied a new set of values are chosen for trial in the function. At times some logic different from that used in choosing the earlier trial variables is used. For computer solution however, a systematic and preset logic must be followed. Let us solve a simple equation

$$x - \frac{1}{2}x - 2 = 0 \text{ —————(1)}$$

by direct iteration. By inspection, of course the answer, $x = 4$ is easily obtained. Let us rearrange equation (1) in the form

$$\frac{x}{n} + 1 = \frac{1}{2} \frac{x}{n} + 2 \text{ —————(2)}$$

where the subscript n denotes the number of the trial. In fig. 8a which is a graphical representation of equation (2) and 45° diagonal representing the condition $x_n + 1 = x_n$.

in this case direct iteration method converges to the required answer after 5 trials when the initial assumed value of x is 1.

If equation (1) however is arranged in the form

$$\frac{x}{n} + 1 = 2^{\frac{x}{n}} - 4$$

figure 8b shows that the method of direct iteration fails to converge to the solution whether the initially assumed value of x is less than or greater than 4. It is true then that the method of direct iteration converges to the solution if the slope of the curve representing the equation is less than unity.

NEWTON-RAPHSON'S METHOD

If it is required to find the value of x such that $f(x) = 0$, this method consists of the repeated use of the first two terms of the Taylor series expansion of $f(x)$ about a fixed value of x say $x = a$, $f(x) = f(a) + f'(a)(x - a)$.

THIELE AND GEDDES

This procedure chooses the temperature profile along the column as the independent variables. This, together with direct iteration convergence method, is used in column design calculations.

LEWIS AND MATHESON

This calculational procedure selects the distribution of each component between the top and bottom products as the independent variables. This procedure combined with Newton-Raphson's convergence method is also widely used in fractionating column calculations.

APPLICATION TO PALMWINE DISTILLATION

It is not possible to design a fractionating column for palmwine distillation based on the afore-mentioned calculational procedures because the composition of palmwine immediately before distillation is unknown and so the bubble point cannot be determined without experimentation.

Fermenting palmwine at 25°C contains among other things :

- (a) Solids—Spent and live yeast and sugar, ash
- (b) Gases—Carbon dioxide, methane, etc.
- (c) Liquids—Water, alcohols, acids, esters, aldehydes
- (d) Oils—Fusel oil.

If the mole fractions of the components were known including those of the heavies (solids) and the lights (gases) it should be possible to use Newton-Raphson's method to determine the bubble point of the fermenting palmwine at one atmosphere for example.

Lack of data and standard on fermenting palmwine compelled us to assume that fermenting palmwine is a binary mixture of ethyl alcohol and water in designing a distillation equipment for palm-wine—a gross over simplification.

OPERATION OF DISTILLATION/RECTIFICATION PLANTS

No matter how highly automated industrial distillation plants may be, the Technological know-how of the person running the plant is not lagging far behind that of the plant designer. He has to read and interpret signals coming from the different monitoring devices in the plant.

CONCLUSION

Since the volume of products coming out of distillation plants consumed either directly by man or by his machines is already enormous and still increasing, the distillation and allied problems of two phase flow and Transport phenomena engage the best of minds in the physical sciences.

(C) LIBRARY SERVICES AND DOCUMENTATION AT THE F.I.I.R.

by B. ARIYO

INTRODUCTION

The F.I.I.R.O. Library is one of the largest and most recognised special Libraries in Nigeria. It has an area of about 858 sq. ft. and is situated on the first floor of the Institute's main building.

Its collection comprises approximately 6,000 volumes of books and pamphlets ; a complete set of British standards ; manufacturers catalogues while nearly 160 titles of scientific and technical journals are currently being taken. The Library holdings cover a wide range of subjects in Science and Technology.

Personnel.—It is manned by two professional and four non-professional staff.

Clientele.—Research officers of the Institute industry and other recommended outside readers.

FUNCTIONS OF THE LIBRARY

The main functions are :—

Controlled procurement of books, periodicals, government publications, pamphlets, gazettes trade catalogues, standard specifications, reference and unpublished materials, etc.

Storage and circulation of publications and documents.

Classification and indexing of these publications and documents in a logical order.

Control of items issued on loan by the Library.

Searching for information in reply to inquiries from within and outside the Institute—, personal assistance to readers.

Keeping newspapers cuttings.

Providing a photo-copy service.

Distribution of Institute publications.

Publication of Institute reports.

Control of Institute exhibition.

Monitoring Institute publicity.

Preparation of Abstracts, subject bibliographies, information index, subject indexes, reading lists for officers—analysing the contents of our holdings in finer detail (Documentation).

ORGANISATION OF THE COLLECTIONS

STOCK

Book collection

There are about 6,000 volumes of books and pamphlets mainly in Science and Technology. We have a basic collection of reference works—bibliographies, national bibliographies, current and retrospective subject bibliographies, handbooks, subject and language dictionaries, indexes, periodical indexes, indexes to government publications as well as to publications of international organisations, encyclopaedias, directories, yearbooks, statistical sources, trade catalogues, etc. The library acquires all UNIDO publications. It ceased being a depository for British Standards in December 1970.

Periodicals

The current issues of periodicals are shelved in the stack while the latest issues are displayed on the rack in the reading section by subject in alphabetical order. A visible index of periodicals in this section displays the titles of periodicals in the Library. Back numbers of periodicals are stored in the old library and may be obtained on request. Bound volumes are shelved in the library staff section. A kalamazoo, which is a register for our periodicals shows the complete history of each periodical added to the library in alphabetical order.

Special materials

Atlases, wall maps, microfilm strips and rolls, slides and photographs are stored in purposely made facilities.

Arrangement of books

The Library is divided into two main sections, viz :— a reading section which seats 12 readers and a work section for use of the Library staff. The books are arranged on the shelves by subject in classified order, i.e. by class number according to the U.D.C. scheme of classification, and according to the order of the cards in the classified file (catalogue) in the reading section. The sequence is from left to right. Reference materials are shelved separately in classified order on the shelf to the right of the entrance while the quick reference ones are shelved on the librarian's desk. Pamphlets are housed in box files. The following outline of main class divisions will act as a guide to getting used with the physical arrangement of the books on the shelves. The class number or location or call mark is marked on the spine of each book.

Key to the Main Subject numbers

- 0 Generalities
- 1 Philosophy
- 2 Religion
- 3 Social Sciences
- 4 Languages
- 5 Science
- 6 Applied Sciences and Technology
- 61 Medical Sciences
- 62 Engineering
- 63 Agriculture
- 64 Domestic Science
- 65 Management
- 66 Chemical Technology/Industry
- 67 Manufactures—Industries based on Processable Materials
- 68 Specialized Trades, Craft and Industries
- 69 Building
- 7 Arts
- 8 Literature
- 9 Geography.

How to find a book in the Library

The catalogue is a cabinet containing small drawers. It is on 3 × 5 inches cards and is divided into three parts :

- (i) *Author/title*.—Entries are arranged by surname or title in alphabetical order.

(ii) *Subject Classified File*.—It brings together all the books on a given subject and arranged by class number 0-9, i.e. in classified order, in the same order as books on the shelves are arranged.

(iii) *Subject (index)*.—Subject (cards) entries are arranged in alphabetical order.

If you know the author or title of the book you want, you can locate it by checking through the author/title part of the catalogue where you would find the card for that particular book and cards for other books by the same author listed by title. The location or class mark in the left corner of the card indicates the whereabouts of this particular book on the shelf. For an example of author card, *see* figure I.

<i>Class number</i>	664.162 (669)		
<i>Author</i>		Nigeria Institute of Industrial Research	
<i>Title</i>		An economic feasibility study for the establishment of glucose industry in Nigeria by J. A. Dina and I. A. Akinrele. Lagos	
		Federal Ministry of Industries, 1970.	<i>Place Published</i>
		29p.	<i>Publisher</i>
<i>illustration</i>		illus. tables, 33 cm.	<i>Date published</i>
			<i>pages</i>
			<i>Size</i>

Figure 1. Author Card filed by author's surname.

ADDED ENTRIES

Put at top of main card (entry)

1. Dina, J. A.
2. Akinrele, I. A. *Jr. Author*

The book in figure 1 would have three cards in the Author/title "Catalogue" index.

If, on the other hand, you only know the subject you can go to the subject index (catalogue) and find it listed under the appropriate subject heading. To find a subject, look under the name of the subject, e.g. Food : Technology 664. Having got the class number you would look under 664 in the classified file where you would find all the books on this subject. Having known the class number of the book you want you can locate it on the shelf. The subject index has the advantage of listing under one subject all of the books in the library on that subject. It acts as a key to the classified file. *see* Figure 2 for an example of a subject card (entry).

Nigeria : Glucose : Industry 664.162 (669)	3"
---	----

5"

Figure 2—Subject Card.

The book in figure 2 would have the following subject headings filed alphabetically in the subject (catalogue) index.

Nigeria : Glucose : Industry	..	..	..	..	664.162 (669)
Glucose : Industry	..	..	..	..	664.162
Sugar Industry	..	..	..	..	664.1
Food Industry	..	..	..	..	664
Industries : Technology	..	..	..	..	66
Technology	..	..	..	..	6
Applied Sciences	..	..	..	..	6

REFERENCE SERVICES AND BIBLIOGRAPHIC ACTIVITIES

Handling and Recording Readers Queries

Reference queries are recorded on 3×5 cards, each containing the following information—name of requesting officer, date of request, name of librarian treating query, answer(s) to query and sources used, date of treatment, etc. Queries are received by various means, by telephone, by mail and by personal contacts.

Investigation of Users needs

The needs of officers are assessed from reference queries received and answers prepared in advance. Bibliographies and reading lists on specific subject are prepared as a result of this assessment.

Sometimes readers unable to locate what they want or wanting to obtain some specific documents or information often ask the assistance of the Librarian who would without delay furnish him either with the appropriate literature or with a written report based on the literature giving him the facts he wants.

Searching for Information about Specific Subject

First of all let us examine how research officers come about their questions.

Main Sources

- (a) Regular reading of periodicals which are circulated to them as they come in.
- (b) References "follow-up"—follow-up of literature quoted in articles.
- (c) Abstracts.
- (d) Personal Index record.
- (e) Reference from correspondence.
- (f) Use of subject bibliography.
- (g) Consult internal reports or publications, e.g. quarterly reports, seminar papers, etc.
- (h) Obtain unpublished material from other research workers.
- (i) Use of Library information index.
- (j) Ask librarian for information.
- (k) Classified subject headings (indexes).

Personal Literature Search

Having received questions the Librarian/Documentalist does a comprehensive literature searching in the following order :—

- (i) Seminar, Conference papers, patents, monographs, often referred to as key publications or single publications.
- (ii) Abstract journals, e.g.—F.I.I.R. abstracts, Food Science and Technology abstracts Tropical abstracts, Chemical abstracts, etc.
- (iii) Library classified catalogue.
- (iv) National bibliographies and indexes.
- (v) Area of research in conjunction with reference follow-up system.

Area of Research

Author's reference list contains the results of their personal contacts with colleagues working in the same field. Methods of contact between research workers are :—

- (1) Exchange of off prints at conferences.
- (2) Through discussion, addresses of colleagues are obtained.
- (3) Through the Library, reports of the Institute are obtained by researchers.

METHOD OF RETRIEVAL OF INFORMATION

Definition of Retrieval Systems

Systems which are employed in order to provide within the bibliographic material access to the literature with regard to its "content". A bibliographic material consists of a compilatory and a retrieval part.

Bibliographic material $\left\{ \begin{array}{l} \text{Compilatory part} \\ \text{Retrieval part} \end{array} \right\}$

FIIR abstracts, e.g. Library catalogue Textbooks.

A retrieval system consists of a number of elements and each element consists of the following :

I—an information carrier—which carries a link between a descriptor (*D*) and the address (*A*) of a document. The simplest example is a reference in an index of a book : cassava (*D*) page 88 (*A*) where the paper or chapter is I and where the selected "document" is a paragraph dealing with cassava in the book itself.

An example of a retrieval system is the F.I.I.R. classified catalogue which consists of :—

- (i) Subject headings arranged in alphabetical order in the subject index—descriptors (*D*)
 - (ii) Location marks or class numbers on subject cards—Addresses (*A*)
 - (iii) Entries on 3×5 cards in the classified file—information carriers (*I*)
- Thus : Nigeria : Cassava : Processing (*D*) + 664.272 (669) *A*. + Main entry is classified (*I*) $\times$ an element. We have several such elements in the classified catalogue.

Having got the original articles or publications the ability to reproduce them in a few minutes is very important. Reproducing facilities available at the Institute are :—

(a) *Copying*—Method used to produce single copies.

(i) *Photocopying* : Equipment—Luxacopy Machine and Apeco systematic Machine

Both are used for reproducing very limited number of copies in the same size as the original in two-four seconds.

(ii) *Optical Photocopying* : Equipment—Helioprint Camera, used to transfer the original on to photosensitised material. (2) Helioprint Repromaster, used for making a master aluminium plate from the photosensitised material.

(b) *Duplicating*—Method used to produce multiple copies.

(i) *Stenciling* : Copies are made using a stencil duplicator. Up to 500 copies can be made from each stencil. This method is used for short runs.

(ii) *Offset Printing* : Method used for long runs to produce very good quality copies. About 600 copies can be made from each paper master and up to 20,000 or more from each aluminium plate. The operation of the 1850 WL offset printing machine, however calls for some considerable technical skill as it is not an ordinary office duplicator. Arrangements are underway to send one of our staff for training on the use of this machine.

At present only the optical photocopying and offset printing equipment are under the control of the librarian. In order to facilitate maximum utilization of library resources and to centralise these facilities it is recommended that the other equipment be transferred to the library to enable the librarian to take full charge of all the reproducing facilities of the Institute as is the practice in other research institutions.

If the articles or publications are not available in our library, the librarian arranges to get them from other local or overseas libraries as the case may be through reproduction or inter-library loan.

Research workers spending all the day in their laboratories cannot be expected also to read all the literature in different languages on their own and related subjects. Instead of putting aside their work and spending perhaps days on searching, they can send their requests to the library staff, who would make a search and furnish them without delay with the appropriate literature that would be the most useful for satisfying their quests. Often, too, in doing this for one officer he will chance upon items likely to interest another officer. Research Officers at the Institute are however, encouraged to do their own literature searching at their spare time as the benefits to them are considerable educationally and as the library staff are under the pressure of time to do other professional duties. The librarian would give them a selection of material to read and show them how they can find more information for themselves.

This function of literature searching undertaken by librarians is sometimes referred to as passive Documentation.

F.I.I.R. PUBLICATIONS

The results of research work are disseminated through the media of various publications listed in our publications list, which is available free on request. Officers of the Institute are encouraged to publish their research results in local and overseas scientific and technical journals of good standing. In addition, the Institute issues publications in the following series :—

1. Research reports
2. Technical memoranda
3. Information Bulletin for Industry
4. Abstracts
5. Contract reports (Confidential)
6. Miscellaneous papers.

DOCUMENTATION

What is documentation ? There are multitude of definitions of the term "documentation" but I am giving only two here :

1. *Definition without delimitation to Librarianship*

It is understood to mean collecting or a collection of documents in a particular field. The attempt was made to delimit documentation by using the word "bibliography". In U.S.A. "Documentation" previously meant special methods of reproduction and information retrieval process. Now they also use the word in its European meaning.

On the basis of the historical origins and of the use of the word by subject specialist a working hypothesis that the field of documentation covers two different processes was arrived at :

(a) The analysis of articles from periodicals which can be extended when necessary to bibliographic control of all types of publications. (Active Documentation).

(b) The different phases of literature searching that research disciplines are ready to delegate (Passive Documentation).

Definition which clearly separates Library from documentation

In general the boundary between the two disciplines can be defined as follows : "as long as the work on an available collection of material refers to one collection, it is, regardless of any further processing, library work ; if it refers, however, to only one specific subject, that is not the totality of one collection, it is documentation. (Loosjes 1967). Documentation is therefore the neighbour of research work which deals with the subject and not stock.

Documentation or information work is of many kinds. It varies with the speciality and range of subject field, with the nature of material to be exploited and according to the users for whom that material is intended. Correspondingly varied forms of organisations have been evolved to handle it. The oldest of this is the library. Documentation attains its full development in the applied technology. The barrier between the research worker and material is here very marked. Research workers do visit the Library but mostly are under a pressure of time that they pass on time consuming activities like documentation to the librarian or documentalists. Their lack of time and disinclination toward paper work make them rely almost entirely upon documentation : The dangers of accepting a list either annotated or not of literature or a critical survey, the original not often consulted, increases the responsibility of the documentalist.

Documentation work at the F.I.I.R.

For a documentation centre like ours to function properly it must have a wide range of primary publications at its disposal. By these are meant publications carrying actual information in its original unabridged form, such as books, journals, and scientific monographs and reports. The F.I.I.R. Documentation Centre, which has just been established, has a library attached to it that houses most of those aforementioned publications. In addition, it has a good collection of secondary publications—Bibliographical references, abstracts, and indexes. Since no single centre can afford to be self sufficient, it has established and maintained close relations with other libraries and information centres within and outside the country.

Abstracting Service : (ACTIVE DOCUMENTATION)

The function of an abstracting service is to collect articles in journals in a subject field in a systematic subject order as the users require. The F.I.I.R. issues a quarterly Industrial

Abstracts the scope of which is limited to articles relevant to the work of the Institute and those on industrial technology in Nigeria. It is a collection of abstracts for researchers who are not accurately served in their specialized subject fields, by general abstract journals. The publication of this abstract has, however, been temporarily suspended due to the demands made on the library staff's time by other assignments.

1. Loosjes, Th.P. (1973) *On Documentation of Scientific Literature* London ; Butterworths.

BIBLIOGRAPHIC MATERIALS USED FOR CONTROL OF ARTICLES IN JOURNALS IN OUR LIBRARY

The four forms of materials are :—

- (i) MS—Manuscripts
- (ii) PU—Publication
- (iii) LMP—Library Material Processed
- (iv) DMP—Documented Material Processed.

Materials from the various sources used for bibliographic control of articles in periodicals are :—

A. INDEXES

1. Subject indexes of separate volumes of periodicals, e.g., Index to separate issues of Nutrition Abstracts or Food Science and Technology Abstracts and index to journal of the Science of Food and Agriculture.
2. Cumulative subject index of a certain set of periodicals, e.g., Annual index to Food Science and Technology Abstracts.
3. Common index of a number of periodicals, mostly called "index", e.g., British Technological Index.

B. LIBRARY CATALOGUES

F.I.I.R.O. Accession Lists, and accession lists of other research and government Institutions—current bibliographies.

C. CURRENT BIBLIOGRAPHIES

—Abstract journals, e.g. Tropical Abstracts.

—Bibliographies of periodical articles without abstracts, e.g., current contents, a very useful easy-to-scan, pocket sized weekly publication that contains the reproduced contents pages of all important journals. We receive "Current Contents Engineering and Technology" gratis, a privilege enjoyed by the Institute owing to the fact that Dr I. A. Akinrele, is a member of the Editorial Board.

NON-CURRENT BIBLIOGRAPHIES :

Literature bibliographies, annotated or selective.

Literature reviews

Key Publications : (surveys, reviews, seminars, etc.).

—Review bibliographies on some subject of topical interest.

—Periodic reviews of periodical literature in the book form, e.g. Annual reviews of.....
progress report of, or advances in.....

—Seminar and conference papers.

MU

PU

LI

Indexes

Catalogues } List periodical
 Accessions } articles with
 lists } annotations at
 times.

MS

Surveys Key reviews
 publications seminars,
 single papers

LMP

List of references
 Abstract } —abstracting.
 journals }

DMP

RE

DO

Fig. 3 The contribution of bibliographic material from the various sectors to bibliographic control of articles in periodicals.

FLOW OF WORK

The procedure is as follows : First, the documentalist circulates the journals as they come in to scientific senior officers, who scan and abstract articles of interest to the Institute. Though the delegation of this abstracting responsibility to officers is wrong as they do not have the required training in this field to do this job, we have to use this measure for the time being until such a time that a trained documentalist is employed to take over this function. Officers will then only be concerned with ticking articles for abstracting in addition to those the documentalist has selected. The journals with the abstracts are sent back to the Library where the documentalist makes the final selection of abstracts. They are then sent to the typing section where they are typed in duplicate on ordinary paper in a particular form. The titles are followed by the author's name ; the name of the journal, the volume number, the number of month of issue (or date if there is more than one issue each month), the year of publication and the starting and final page numbers, all in brackets at top of the abstracts. The typed abstracts are sent back to the Library where they are classified and arranged in classified order. They are then sent to the typist for typing on master paper. The master plates are sent to the Library to be corrected. After they are corrected they are later sent to the Government Printing Division for printing. Printed copies are circulated to the people on our mailing list.

PROBLEMS WE ARE FACING

—*Coverage*.—Not all the journals in industrial Technology are covered as the number of journals purchased is limited by funds available.

—*"Scatter"*.—To avoid this we scan articles in non-scientific journals like *Nigerian Opinion, Drum, West Africa, Dailies* and broad journals like *Science and Nature* in which they are least expected. House journals like *Topic* and *Mobil News* are also scanned because they carry articles often omitted in broad periodicals.

Topicality

This is the worst problem we are facing. The time lag between the publications of the original article and its appearance in F.I.I.R. abstracts is long. This is due to many factors, mainly lack of time. The Library staff are under pressure of time to do other professional and non-professional duties. In other documentation centres, even those of F.I.I.R.'s size, a documentalist is employed to do this service as a full time job. Other factors are delays by officers in returning journals to the library after reading them, therefore, contributing to the time lag and long distance from international sources.

There has been a back log of abstracts for as far back as 1965. We have been working very hard to bring its publication up to date. Some of you might suggest that since these abstracts would be out-dated by the time they appear, why not leave out those for this period. But one must remember that an abstract serves both current and retrospect work. An officer may wish to know all the works published between say 1967-1968 by an author or on a particular subject. If abstracts for this period have been omitted there will definitely be a gap. An abstract can never be obsolete.

It is hoped that, as soon as the intermediate cadre of our staff are trained to handle with confidence and accuracy the semi-professional duties, the documentalist would be relieved of these routine but necessary tasks for other professional jobs. Training programmes for members are, therefore, very essential.

INFORMATION SERVICE TO INDUSTRIES

Objectives.—To keep industries abreast of the continuing development of new techniques and processes of the Institute relevant to Nigerian development ; to compile information on investment opportunities in the Nigerian industrial sector and compile information related to publications on industrial development in Nigeria.

To achieve the above objectives the following actions have been taken—A quarterly technical information Bulletin for Industry has been inaugurated. An Industrial Manual has been prepared and a bibliography on Industrial development in Nigeria is in preparation.

The importance of Scientific Documentation in industrial development of Nigeria cannot be over-emphasised. Documentations centres are strong hold of research. Economic, technical and Industrial development of any nation depends on the results of research. Bibliographers assists in exchange and it creates contact with the industrialised countries and makes it easier to secure books, periodicals and especially scientific reports and other literature that are normally difficult to get.

(d) INVESTIGATION AND CHARACTERISATION OF NATURAL AND DERIVED FLAVOUR ESSENCES OF INDUSTRIAL INTEREST

by DR S. I. AHONKHAI

INTRODUCTION

Definitions.—Flavours are substances used for the stimulation of the 'natural' senses of taste, odour, mouth-feel and kinesthetics. Of these, the most important are the sensations of taste and odour.

It is generally agreed that there are four fundamental tastes, namely, sourness, saltiness, sweetness and bitterness : saltiness and sourness are most commonly produced by ionizable substances while sweetness and bitterness are, in the main, produced by unionizable substances.

Unlike the sensation of taste, there is no fundamental classification of odour. The terms 'Fragrance', 'Acidity' 'Pungent', 'Burntness' and 'Goatiness' or their combinations are used to describe a particular odour. In general however they are not specific.

The kinesthetic sensation is the sensation attributable to the muscular effort involved in the process of chewing. It is different from the sensation of mouth-feel which is the sensation stimulated by the smoothness or granular character of the food. The sensation of mouth-feel is also noticed when carbonated products such as soda and beer are consumed. The bubbles of carbon dioxide impinge on the walls of the mouth to give a characteristic sensation. The sensation of warmth or hotness or 'biting' caused by some substances in pepper, ginger and the like and the sensation of coolness caused by menthol and substances in peppermint oil are also classified under mouth-feel.

'NATURAL' FLAVOUR AND 'DERIVED' FLAVOUR

The principal components of food (proteins, carbohydrate and fats) are relatively low in flavour. Sugar is the only major ingredient of food with appreciable flavour intensity. It is therefore mostly the trace substances present in foods that furnish its flavour characteristics.

Some foods grown without treatment have good flavour. This 'Natural' flavour is obtainable mostly amongst plants and vegetables. Other plants, not necessarily used as food are grown mainly for their flavour contents and those parts in which their flavour properties are concentrated are harvested and processed for the production of flavour. The flavouring properties of a plant or vegetable could be found either in the root (as chicory, garlic, ginger, onion) in the bark (as cinnamon, elm, slippery) in the leaves (as pine-apple mint, rosemary, thyme) in the flowers and buds (as clove, jasmine) in the fruit (as cardamon, parsley) in the peel of the fruit (as orange, lemon, lime, grape) in the seed (as coffee, cocoa, cashew, vanilla, nutmeg) and in the saps, gums and other exudations of the plant (as gum arabic, honey, gum benzoin). At times different volatile oils are obtained from different parts of the same plant. An example is the essential oils obtained from the orange tree. The peel of the fruit yields orange oil, the flowers of the orange tree yield oil of neroli, and the leaves yield still another essential oil—petitgrain oil.

Other foods have to have their flavour developed by the action of heat. Meat, fish, eggs, gari are few examples of foods in this class. Such type of flavour developed during the processing of a food, drink or any consumable substance could be called 'Derived' flavour.

IMPORTANCE AND FIELD OF APPLICATION

The importance of flavour cannot be over-estimated. Its presence is not only inevitable in the processes of all types of foods and drinks, its uses in Pharmaceutical products (effervescent tablets, syrups, drops, etc.) cosmetic products (toothpastes and other oral-hygiene products) Tobacco (cigarettes, filter aromatics, pipe tobacco) and animal feeds is also increasing daily. Apart from all these, it is now becoming of increasing importance to analyse the flavour components of a food as produced ordinarily in order to regulate and ensure its fullness in the large-scale (often mechanised) production of the food.

METHODS OF PRODUCTION

It has already been stated above that natural flavours occur mostly in plants and vegetables. Apart from some 'Herbs' and 'Spices' (an aggregation of sun-dried flavouring agents of plant origin which are characterised by strong pungent odours, biting mouth-feel and sometimes sweet or bitter taste) which are used wholly as additives to foods and drinks the natural flavours from plants often known as "Essential Oils" are separated from the mass of plant material by one of these methods :

(a) *Distillation* : Three types of distillation are often used. These are :

(i) *Water Distillation* where the plant is mixed with water in a still and then heated.

(ii) *Water-Steam Distillation* : Here, the plant material is supported on a perforated plate or gauze constructed a little distance above the bottom of the still. The water level in the still is kept below the plate. The still is heated and the distillate is collected through an outlet as shown in fig. 1.

(iii) *Steam-Distillation* : Here the plant material is supported on a gauze in the still but no water is added. Steam is passed into the still from an outside source.

(b) *Expression* : By this is meant the squeezing out of the essential oil from the plant material. This is the method often used for obtaining the essential oils from the pods of citrus fruits.

(c) *Maceration* : By this method, the plant material is steeped in water for several days. The resultant solution is filtered and if desired concentrated by heating.

This method is fast fading out.

(d) *Extraction* : Most essential oils are now obtained from their plant parts by extraction with volatile organic solvents. The resultant concentrates are dissolved in ethanol of a standard strength and marketed.

ANALYTICAL INVESTIGATION OF FLAVOURS

The need to investigate the components of natural flavours analytically and characterise them can hardly be over-emphasised. In a world where Food Processing industries are proliferating, liquor processing industries and Breweries are expanding, Pharmaceutical industries are investing much money into the improvement of the organoleptic properties of their products, Tobacco companies are daily thinking of means to improve the taste and aroma of their products, Cosmetic factories are placing more emphasis on increasing the intensity of the fragrance of their products, to enumerate just a few, it becomes quite obvious that the supply of natural flavours will always be several paces behind demand. Consequently, other avenues of producing flavours must be opened. If only for this reason, much energy should be geared into the analytical investigation of a natural flavour with the view of knowing its chemical components, their various proportion by weight and a possible route of synthesising it.

Such types of investigations are always painstaking and require the use of highly sensitive analytical instruments. Almost all flavours are complex, being made up of numerous and various chemical compounds in such a unique proportion as to produce those stimuli for each separate sense, the combination of which is characteristic and quite different from those of the individual chemical components. Thus groundnut flavour, ordinary as it is, is made up of seven different hydrocarbons, three different alcohols, twenty-one different aldehydes, three different ketones, thirty-nine different acids, one ester and twelve other chemical compounds. (Vegetable volatiles : a survey of components identified—Part I by A. E. Johnson, H. E. Nursten, and A. A. Williams, *Chemistry and Industry*, May 1971, page 561).

The analytical investigation of a flavour or an essential oil with the aim of identifying its chemical components in general requires three steps.

(a) The flavour of the substance is extracted by one of the methods afore-mentioned—viz Distillation, Expression, Maceration, Extraction with volatile organic solvent.

(b) Attempts are then made to separate the chemical components of the flavour. This is often done by chromatographic techniques. (Chromatography is the method of separating an intimate mixture of chemical compounds into their different components as a result of their different degrees of absorption on a stationary phase or partition between a stationary and a mobile phase).

There are, at present, six methods of chromatography : Column chromatography, Thin-Layer Chromatography, Paper chromatography, ion-exchange chromatography, Gas-Liquid chromatography and Gas-Solid chromatography. Of these, the most effective and sensitive is Gas-Chromatography (Gas-Liquid or Gas-Solid).

(c) In the last step, attempts are made to identify the various chemical components of the flavour separated in (b). In doing this, various other highly sensitive analytical instruments like the Infra-Red, nuclear magnetic resonance and mass spectrometers are often used.

CHEMICAL COMPOSITION

In general, the components comprising an essential oil can be placed into two principal categories : a hydrocarbon portion which is usually the major part of the essential oil and a portion consisting of many oxygenated components. The oxygenated components may be placed into the usual organic chemistry groups of acids, alcohols, esters, aldehydes, ketones, ethers, lactones and polyfunctional compounds. In addition to the two groups above is the group consisting of sulfur-bearing components (such as sulphides, mercaptans) and nitrogen-bearing components. *see fig. 2.*

The hydrocarbon component often consists of terpenes, sesquiterpenes and polyterpenes which are polymers of the parent constituent, isoprene (C_5H_8). The monoterpenes, ($C_{10}H_{16}$) are monocyclic like limonene (which occurs in lemon and orange oils) sylvestrene (which occurs in pine needle oil) or bicyclic like myrcene (which occurs in verbena and bay oils) and ocimene. Similarly, sesquiterpenes ($C_{15}H_{24}$) may be monocyclic like Bisabolene (which occurs in the oil of myrrh and various other essential oils) zingiberene (which occurs in ginger oil), bicyclic like selinene (which occurs in celery oil), cadinene (which occurs in the oil of cubebs) and acyclic like Farnesene (which occurs in the oil of hop).

The hydrocarbon content of some essential oils is very high. For instance, the hydrocarbon component of lemon, orange, lime and other citrus oils is over 90 per cent and at times reaches 98 per cent. Calamus, ginger and juniper oils contain from 85 to 90 per cent of terpene and sesquiterpene hydrocarbons.

In some essential oils, the oxygenated components is also high. Thus over 98 per cent of oil of wintergreen consists of methyl salicylate ; the oils of cassia and cinnamon contain from 70 to 90 per cent of cinnamaldelyde ; Eugenol comprises about 70 per cent of clove oil ; citral comprises 60 to 80 per cent of lemon grass oil ; and by definition over 50 per cent of oil of peppermint must be menthol.

SYNTHETIC FLAVOURS

One major result of the analytical investigation of flavours (natural or derived) and essential oils is the production of synthetic flavours. They are made from the mixtures of various synthetic esters, aldehydes, ketones and alcohols. In some cases small amounts of chloroform and various organic acids such as acetic, citric, tartaric, succinic and benzoic acids are also used. These mixtures are usually dissolved in alcohol with or without the addition of small amounts of glycerol and are sold in the concentrated form.

The flavours imitate very closely the taste and aroma of natural flavouring agents. They are used in large quantities by the manufacturers of soft drinks, candies, ice cream and various other confections.

PROSPECTS FOR THE PRODUCTION OF FLAVOURS OR ESSENTIAL OILS IN NIGERIA

Essential oil bearing plants grow abundantly in Nigeria. Some of these are the various grasses (such as lemon grass, cane sugar), citrus plants (such as those of lemon, orange, lime, cashew, grape, banana, tangerine, guava, pine-apple, mango, avocado pear) palms (such as coconut and date), groundnuts, ginger, onion, melon, cola, cocoa, etc.

Apart from the sugar industry, very little is done in Nigeria to extract the essential oils from these plants and determine their active principles. All the flavours (natural and synthetic) and essential oils used by the soft-drink manufacturers, Breweries, Liquor Distillers, Perfumes, Cosmetics, Soaps and detergent industries, confectioneries and tobacco industries, to mention a few, in the country are imported. It therefore becomes very essential to investigate the essential oils of our plants with a view to opening flavours and essential oils industry in Nigeria. Should such a scheme come through, and judging from the number of industries in the country using flavours and essential oils, a substantial amount of our foreign exchange will be saved.

WORK AT F.I.I.R.

Realising the importance of flavours and essential oils in the economic development of Nigeria, it was decided to investigate and characterise the active principles of the natural flavours and essential oils obtainable from local resources.

The F.I.I.R., is reputed for the mechanised production of Gari from cassava. Also gari is produced locally, mostly by the wives of farmers, in many rural areas of Southern Nigeria. Hitherto, there is no standard method of production so that the quality of the end product—gari, varies from one producer to another. Buyers of gari are, as a result, completely helpless when it comes to choosing gari of good quality. Consequently it was decided to investigate and characterise, first and foremost, the flavour of gari partly as a means of quality control on its production and partly as a means of enhancing (or at least maintaining) its organoleptic characteristics now that it is produced on a large scale.

INVESTIGATION AND CHARACTERISATION OF GARI FLAVOUR

Of the various types of gari produced in the country, it was decided to use for the test, the mechanically produced gari at F.I.I.R. for the following reasons :—

- (i) The taste and aroma of gari produced at F.I.I.R. is acceptable to the consumers of gari in all its preparations for food.¹
- (ii) The toxicity of F.I.I.R., gari (measure as Hydrocyanic acid content) is quite less than the average toxicity of the various samples of gari produced locally in the rural areas ; being 10 and 19 ppm respectively.²

The flow-chart showing the various steps of investigations of gari flavour and attempts at characterising its chemical components is attached.

EXTRACTION OF FLAVOUR FROM GARI

Several methods were used to extract gari flavour from a sample of gari :—

- (i) A fresh sample of gari was dry-distilled under partial vacuum. The volatile constituents were made to pass through traps cooled with ice-salt mixture, for condensation.

The distillate was found to have just a faint aroma of gari. The bulk of the aroma was still in the initial sample of gari. The refractive index of the distillate at 24°C was found to be 1.3410. It was then concluded that the distillate was mainly water.

- (ii) The gari residue from (i) was subjected to soxhlet extraction using ether. The extract (A) obtained was golden yellow in colour and has an aroma close to that of gari.

(iii) Another fresh sample of gari was extracted with a 70 per cent aqueous solution of ethanol. A reddish-brown extract, highly viscous with a concentrated aroma of gari was obtained (B).

(iv) The residue from (iii) was still found to smell like gari. It was further extracted with methanol. A brown extract, (C) also viscous with a strong aroma of freshly fried gari was obtained.

METHODS OF INVESTIGATION

Having obtained the extract, the following steps are usually undertaken :

- (1) Determination of its Infra-red spectrum.
 - (2) Determination of some of the components of the extracts by Thin-Layer Chromatography (t.l.c.)
 - (3) Determination of the various components of the extract by gas chromatography.
- Should a crystalline substance (or a solid) separate out from the extract on cooling, the following steps are usually taken to identify the solid.
- (4) Purification of the solid either by recrystallisation or thorough washing.
 - (5) Determination of the melting point of the solid.
 - (6) Determination of its Infra-red spectrum (KBr-disc)
 - (7) Determination of its thin-layer chromatogram.
 - (8) Determination of its n.m.r. spectrum (if it is a single substance)
 - (9) Determination of its carbon and hydrogen content.

All the extracts A, B and C above were found to contain some crystals on cooling. Moreover, their thin-layer chromatogram showed that they were a mixture of many substances. Consequently, in addition to the scheme of investigation shown above, the following steps were found necessary.

(a) The extracts were subjected to column chromatography using different solvents (often petroleum-ether, or Hexane, Ether and methanol).

(b) The extracts were subjected to 'preparative' thin-layer chromatography.

The different fractions obtained in (a) and (b) were again subjected to tests (1), (2) and (3).

Following this type of scheme, the following compounds were identified in the ether extract (A):

Acetic acid, propionic acid, Butyric acid (by Gas Chromatography) and succinic Acid (by m.pt. Infra-red spectrum and t.l.c.)

From the ethanol/water extract (B),

Lactic acid, succinic acid were identified (by t.l.c.) and d-l arabinose was identified (by m.pt., n.m.r. spectrum and percentage carbon and Hydrogen content).

And from the Methanol Extract (C),

Lactic acid, succinic acid were identified (by t.l.c.) and a white crystalline compound of m.pt. higher than 340°C has been obtained.

There is no doubt that the sour taste of gari is due to the acids already indentified above. More work is still being done to determine their proportions by weight. It is hoped that very soon, the ingredient (s) which impart (s) to gari its characteristics aroma will soon be identified.

(e) PULPING TRIALS ON SELECTED NIGERIAN PLANT MATERIALS

by Mr J. O. ALOKWEM

INCREASED DEMAND FOR PULP AND PAPER IN NIGERIA

Paper and paper board are very essential for both the cultural and economic development. Newsprint and other printing and writing papers are needed for information, for education and in business life ; wrapping papers, paper boards and corrugated boards are essential for distribution of consumer goods, etc ; speciality papers are required for a variety of industrial purposes ; security papers are used for bank notes, cheques, stamps, etc. All over the world the need for paper increases. At present the total world consumption of pulp and paper increases approximately 5 per cent annually.

PER CAPITA PAPER CONSUMPTION IN NIGERIA

To make pulp and paper industry economically viable in this country, paper consumption must be encouraged. In this part of the world, per capita paper consumption is very low—about 1.8Kgs. It is noted that in this country consumers fall into two completely different classes, the first consisting of a handful of high-income consumers living according to western standards, and using a great deal of papers, while the great mass of consumers fall into the low-income category with an extremely low per capita consumption of paper, sometimes practically nil.

Political difficulties and disturbances may have retarded paper consumption of this country a great deal in the civil war era. However, rapid industrial and commercial development after the disturbances may abruptly and positively alter the paper market situation to considerable extent. Market demands for paper products for this country which were obtained from records of the Federal Office of Statistics could prove this. (Note the sharp rise immediately after the war—1970). The records indicate that Nigerian paper imports increases yearly since the end of the civil war—see fig. (a) Increase in Nigerian paper imports (Paper Consumption).

TABLE 1

Year	Quantity (tons)	Value N	Year	Quantity (tons)	Value N
1963	31,365	6,966,064	1968	35,841	8,209,692
1964	32,940	8,296,696	1969	39,842	7,609,702
1965	39,072	9,050,714	1970	63,265	17,118,606
1966	34,979	8,524,912	1971	88,510	20,899,880
1967	31,956	8,054,012	1972	35,343	(Jan-June) 9,281,428

Import average annual increase is about 15 per cent, therefore, demand projection for 1972-1980 is as follow : (according to NISER Consultants).

TABLE 2

Year	Estimated demand (tons)	Year	Estimated demand (tons)
1971	88,510	1976	178,000
1972	101,800	1977	204,700
1973	117,000	1978	235,400
1974	134,600	1979	270,700
1975	154,800	1980	311,300

INFLUENCE OF SPREAD OF EDUCATION

With gains in education there is supposed to be another abrupt change, 10-20 years from now, as the generation which is now learning to read and write reaches the point of becoming interested in newspapers, magazines and books.

The easiest way to measure adult literacy (therefore paper consumption increase) is to examine the increase in primary school enrolment according to the United Nation's Statistical Year Book.

TRENDS IN PRIMARY SCHOOL ENROLMENT

TABLE 3

	Primary School Pupils 103 10 ₃		Annual Increase-percent	
	1950-51	1960-61	Pupils	Total population
West Africa	1553	4347	11	2.3

As will be seen, the rate of increase of school enrolment is higher than that of population. The first anticipated effect of such an increase will be the greater consumption of printing and writing paper in the schools. Further increase in paper consumption is envisaged in a long-term forecast, when most of the books used in our schools must have been printed locally.

RAW MATERIAL FOR ESTABLISHMENT OF PULP AND PAPER INDUSTRIES IN NIGERIA

I have proved above the need for establishment of pulp and paper industries in this country, what remains now is to prove to you too, that Nigeria is abundantly rich in raw materials for this basic industry.

Wood is of course by far the most predominant raw material for paper pulp. Africa's largest resources of fibrous raw materials lie in the tropical rainforest in West Africa (Nigeria). The utilisation of these forests, which consist of a large variety of broad leaved species, as raw material for pulp and paper manufacture poses no unsurmountable technical problems. Laboratory research in our Institute has amply confirmed this. Ref. previous Research Report studies on the economic availability and technical suitability of these tropical hardwoods for pulp and paper manufacture had been encouraging. Though the most significant feature of the tropical rainforest is the heterogeneity of its botanical composition, it has been confirmed that adequate extraction techniques are established for these species.

A few decades almost only softwoods were used for paper pulps. In the 1940's and even in the 1950's hardwood chemical pulps were generally regarded as inferior to soft wood chemical pulps for paper production. Traditionally the short fibres from hardwoods were looked upon as

less useful for paper than the long fibres from softwoods. Today, through research and experience a re-evaluation has taken place. Now there is and is still going to be a marked shift towards more use of hardwoods for pulp production. May be that the marked shortage in raw material and severe competition in woodpulp production coupled with price situation, is forcing the world pulp industry more and more to accept hardwoods specie for chemical, semi-chemical and mechanical pulp.

The global supply of softwoods is limited, whereas hardwoods are relatively abundant. It has been estimated by the F. A. O. that during the 1980's all economically available soft wood forest in the world (except the USSR) will be exploited, assuming sustained yield. It is thus natural that in the future the additional pulp and paper production will be based mainly on hardwoods.

The planning of maximum economy in the use of available raw materials can be helped substantially by a better recognition, through more intelligent quality assessment and testing, of the basic functional requirements of papers in their many different fields of use. What I mean is this, that papers from hardwood pulps could be produced to satisfy to an extent certain functional requirements. We do not expect initially a 100 per cent satisfaction. Trully speaking, paper that is too good for its job represents a waste of both money and raw material.

Some useful studies have been done in this field of research and it is our intention not to duplicate the work already done by our predecessors. I will refer you to some of the papers published on the subject, and whoever is interested may pick up these research reports (see table 4) In these reports some species have been recommended as suitable pulp-wood for paper production, and both chemical and physical analysis had supported this claim.

OUR NEW WORK

Our new line of research tends towards the same ground. As the result of the research recommendation from this Institute almost ten years ago, the then Regional Governments had embarked on large development scheme of man-made forests of Gmelina arborea and Eucalyptus species for pulp industries. The growth circle for these species was purported to be 5-10 years. Now that these trees are overdue for felling (harvesting), and there are no pulp industries to utilise them, the forest experts express, the fear that the wood may present some pulping problems during production. To clear this fear, we started experiments on Gmelina of different age groups, to determine their chemical, physical and morphological characteristics.

REFERENCE TO PREVIOUS STUDIES

<i>Authors</i>	<i>Research Report No.</i>	<i>Specie</i>	<i>Density</i>	<i>Conclusion</i>	<i>Type of cook</i>
A. E. CHITTEND D. G. COURSEY J. O. ROTIBI	17	Gmelina Arborea	23.5lb/cu. ft. O.D. 37.5 telling	(1) Chemical sulphate cook gave satisfactory paper. (2) Semichemical pulp is good for manufacture of carton boards or for liners and for lower grade wrapping paper potentially suitable.	Sulphate semichemical.
D. G. COURSEY	22	Cedreld	15.4lb/cu. ft.	Sulphate cook gave poor paper	Suplhate semi-

O. A. OGUNLE		Odorata	30.2 wet	Semi-chemical pulp gave poor yield and low quality paper. Hot potentially suitable.	chemical
D. G. COURSEY N. CROSSLEY O. A. OGUNLE	23	Oxystigmg mannil	25.5lb/ cu. ft.	Sulphate pulp gave a fair paper but difficult to bleach. It could be good for liners and boards. Semi-chem pulp gave a poor yield and poor paper. Difficult to bleach. Not potentially suitable.	Sulphate semi- chemical
N. CROSSLEY O. A. OGUNLE	24	Triplo- chiton Scleroxylon	15.7lb/ cu. ft.	Sulphate pulp gave strong paper but was of a poor yield semi-chem was difficult to bleach, therefore this specie may not be a potential pulp-wood.	Sulphate semi- chemical
N. CROSSLEY O. A. OGUNLE	25	Terminalia Ivorensis	20.2	Sulphate pulp gave an extremely strong paper and was fairly easily bleached. Semi-chem pulp could be used for liners and boards. Potential pulp wood.	Sulphate semi- chemical
N. CROSSLEY	30				
O. A. CGUNLE	31				
	32				

(Table 4) Research Reports on Pulp and Paper.

PULPING METHODS

Our research laboratory for pulp and paper started work more than ten years ago and much should be credited to the management of the Institute for its foresight, having provided the best equipped paper laboratory in the country.

The main methods we use in our laboratory for production of pulp are :

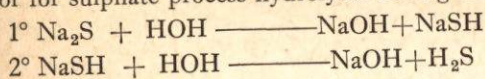
1. Chemical
2. Semi-chemical

CHEMICAL PULPING

The purpose of every chemical process for cellulose production from pulp-woods or non-wood material is to reduce all non-cellulosic content of the raw material thereby liberating the fibres. At the same time, during the extraction of the non-cellulosic materials, no damage should be done to pure cellulose. *Sulphate or Kraft method.* In our experiments we used the sulphate method for the production of paper pulp. In this process, the principal chemicals used for the separation of non-cellulosic substance from the raw material are :

- 1° Sodium hydroxide (NaOH)
- 2° Sodium Sulphide (Na₂S)

Effect of alkaline on the raw material during sulphate pulping process is such that NaOH dissolves non-cellulosic portion of the raw material. Sodium sulphide present in the cooking liquor for sulphate process hydrolyses during the cook as follow :



During the cooking process, hydrolytic degradation of lignin, hemicellulose and partially cellulose, takes place. The amount of hydrolised and degraded cellulose depends on the degree of delignification of the raw material (see fig. 1). It follows that the higher the degree of delignification, the higher the degradation of cellulose and vice-versa. It should be noted too, that during the cooking process, saponification of resin and fat contained in the raw material takes place.

FACTORS WHICH INFLUENCE THE SULPHATE COOK

For successful cooks during our experiments, the following parameters were thoroughly under control :

1° Temperature. Effect of temperature on a sulphate cook can be seen from fig. 2., which shows the influence of temperature on pulping. From the diagram, it is intended to show that an increase in temperature by 10°C, more than doubles the speed of reaction.

2° Amount of active alkali.

The ratio of chemical to raw material affects the yield, increase in chemical reduces the yield.

3° Sulphidity of the cooking liquor (amount of Na₂S). Influence of sulphidity of the cooking liquor on a sulphate cook can be seen from fig. 1. It can be seen that increase in sulphidity increases the cooking effect. However, optimal sulphidity is maintained at amount 15-31 % sulphidity indicates the relation of sodium sulphide (Na₂S) to total alkali (Na₂S + NaOH) in the liquor, expressed in percentage :

$$\% \text{ sulphidity} = \frac{\text{Na}_2\text{S}}{\text{Na}_2\text{S} + \text{NaOH}} \times 100$$

4° Concentration of alkali :

Increasing the concentration of alkali twice equally reduces the cooking time, twice.

Though higher concentration of alkali reduces the cooking time, the product of the cook contains more lignin and less alpha cellulose. This is not desirable, however.

- 5° Time (see fig. 3, change of temperature during sulphate cook)
 6° Quality of the raw material used
 7° Condition for chip penetration
 8° The method of liquor circulation

OUR RESEARCH RESULTS FROM GMELINA ARBorea

Age		4	5	6	8	9	Conclusion
Resin Content %	.. ..	4.63	6.44	9.75	9.78	9.80	increases with age
Nolocellulose %	.. ..	80.84	80.39	75.59	73.74	73.04	decreases with age
Alpha cellulose %	.. ..	56.53	56.06	52.59	52.28	51.80	decreases with age
Lignin Content %	.. ..	30.57	29.60	25.20	23.98	22.38	decreases with age
1% alkalisolubility %	.. ..	8.25	11.77	12.00	12.50	13.75	increases : Yield
							Reduct.
Cold Water solubility %	.. ..	5.02	5.53	7.70	4.26	5.95	
Hot Water solubility %	.. ..	5.85	5.94	9.60	4.53	6.99	
Ash content %	.. ..	0.65	0.70	1.32	0.88	1.00	

PHYSICAL ANALYSIS

(Optical studies)

7		4	5	6	8	9	
Fibre length mm	.. ..	1.058	1.062	1.012	1.066	1.070	Seems to increase with age
Fibre width mm	.. ..	0.029	0.028	0.025	0.026	0.027	
Fibre Lumen mm	.. ..	0.027	0.026	0.023	0.025	0.025	
Wall thickness mm (?)	.. ..	0.001	0.001	0.001	0.001	0.001	

From our findings as stated above, we can draw the following conclusions :

RESIN

1. The percentage of resin in the pulp-wood tends to increase with age. See fig.4. High resin content in pulp-wood causes pitch trouble during pulping process, but since sulphate method is the recommended process for hardwoods, there would be complete saponification of all resins during the cook.

2. 1% alkali solubility. This is a very important parameter which determines the degree of fungal attack on the wood. Brown rotting fungi, and other micro organism cause decay which may seriously affect the pulp yield and the paper strength properties of kraft pulps. Our research results indicate that solubility of the pulping raw material in 1% NaOH increase with age. This automatically means reduction in yield—see fig. 5. Due to some very difficult problems, we were not able to complete pulping trials to compare yield of different age groups. Until we do this, we can only base our conclusion on yield deterioration due to age, on theoretical grounds, i. e. on the result of 1% alkali solubility.

3. Halocellulose, alphacellulose, lignin as indicated in fig. 6, Holocellulose, and cellulose and lignin tend to decrease with age. This is obvious to happen since yield is affected.

From the result of the physical studies of the fibre, it was observed that there was no remarkable increase in the fibre length in older trees.

With all the above mentioned findings in view, we recommend that these trees be harvested from the earliest harvesting circle (age),