

Nowrosjee Wadia College, Poona

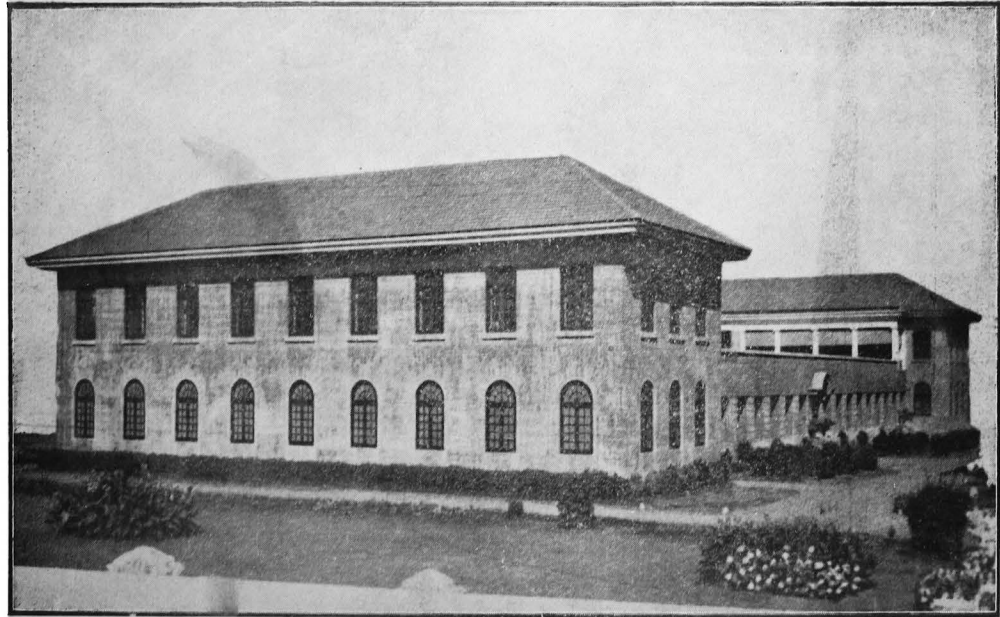
Department of Bio-Chemistry



RESEARCH PAPERS
ON
FOOD PROBLEMS

SEPTEMBER
1949

With greetings
The Newsjee W. ...
+
Compliments of the Editor
to
S. G. Vakey



The Vicaji D. B. Taraporevala Institute of Science.

Nowrosjee Wadia College, Poona
Department of Bio-Chemistry



RESEARCH PAPERS
ON
FOOD PROBLEMS
1938 - 1948

Under the guidance of

Rao Bahadur Dr. D. L. Sahasrabuddhe, D.Sc., M.Sc., M.Ag., F.A.Sc.,

Honorary Professor of Bio-Chemistry, Nowrosjee Wadia College, Poona

and

Dr. N. V. Bhide, M.Sc., Ph.D.,

Professor of Chemistry, Nowrosjee Wadia College, Poona.

Printed by K. D. PANSE, Manager, at the "ISRAELITE PRESS",
6, Church Road, Poona
and
Published by Principal V. K. JOAG,
at the Nowrosjee Wadia College, Poona.



The late Mr. Vicaji D. B. Taraporevala.

To

The Memory of

The late Mr. VICAJI D. B. TARAPOREVALA

whose generosity enabled the College

to provide an excellent home for its Science Departments

in

The Vicaji D. B. Taraporevala Institute of Science.

This volume of research work done in the Institute

is

Dedicated

As a token of gratitude.



His Excellency Raja Sir Maharaj Singh,
Governor of Bombay and
Chancellor of the University of Poona.

FOREWORD

When I was asked by Principal V.K. Joag to write a foreword to this useful and interesting publication, I readily agreed for what seemed to me to be two good reasons: First, because the publication is appearing at a very opportune moment, and second, because it is, I understand, the first book of its kind which has been compiled in Maharashtra since the establishment of the University of Poona.

In my recent Convocation address to that University I emphasised the great value of research work not only for the interest which it rouses in the students but also for the national interests which it promotes. We have been repeatedly told that one of the gravest problems facing India at present is the shortage of food, and our leaders have by word and example been doing all that lies within their power to step up the production of food so as to make our country self-sufficient in the near future. At such a moment, the publication of the result of years of research in problems concerning food is not only opportune, but shows very commendable public-spirit. The vital importance of nutritional analysis and bio-chemical research cannot be overestimated.

I congratulate those students of the Nowrosjee Wadia College, Poona, who have, under the able guidance of Dr. D.L. Sahasrabudde and Dr. N.V. Bhide, contributed their thought and their talent to this valuable work. A meed of praise is also due to the authorities of the College on their encouragement and assistance, without which this contribution would have remained unknown to the public.

GOVERNMENT HOUSE
Ganeshkhind,
September 12, 1949.

MAHARAJ SINGH
Governor of Bombay.

encouraged his students to undertake research on problems relating to food.

During these 12 years, Dr. Sahasrabuddhe and his students have worked on many such problems and have produced valuable results. The students have received recognition from the University of Bombay for their work. They have been awarded the M.Sc. and Ph.D. degrees.

The theses submitted by these students for their degrees are now being published by the College at its own cost. Some of them were originally published in the Bombay University Journal and similar other periodicals. They have been revised, condensed, and made suitable for inclusion in this publication.

We are happy that within a few months of the establishment of the University of Poona we have been able to bring out this volume of research papers. We believe, that this is a happy augury for the new University. We have no doubt that the University will encourage its constituent Colleges to continue such work and thus supplement its own efforts for the promotion of research and advancement of learning.

We thought that it would be very appropriate that we should have for the volume a foreword from the Chancellor of the new University, H. E. Raja Sir Maharaj Singh, the Governor of Bombay and so we approached him and we are happy to state that he readily agreed and sent his foreword. We take this opportunity to convey to H. E. our grateful thanks.

Our thanks are also due to the authorities of the Bombay University and the Editors of the Journals in which some of the papers were first published for permission to publish these papers in this volume.

The provision of an excellent building for housing our Science Laboratories was made possible by the generous donation of Rs. 80,000/- given by the late Mr. Vicaji D. B. Taraporevala towards its cost. Without a suitable building it would not have been easy for the College to under-

take such research work. We have, therefore, thought it appropriate that this first publication of its kind undertaken by our College should be dedicated to the memory of Mr. Taraporevala. It is to us a matter of deep regret that Mr. Taraporevala is not alive to see this publication.

We cannot close this preface without expressing our thanks to Mr. M. M. Thatte, M.Sc. and Mr. V. S. Kulkarni, M.Sc. for the valuable help they gave in preparing the papers for the Press and reading the proofs. Thanks are also due to the Proprietor and the Managers of the Israelite Press for the readiness with which they undertook and the thoroughness with which they carried out the printing work of this volume. But for their ready help it would have been difficult for the College to produce the book in such an attractive form.

NOWROSJEE WADIA COLLEGE }
15th September 1949. }

V. K. JOAG.

CONTENTS

Paper	Title	By	Page
	Introduction	... Rao Bahadur Dr. D. L. Sahasrabudde, D.Sc.	... i—xv
I	Comparative Disintegration of Flours and Starches with Hydrochloric acid, Diastase and Pancreatin.	Dr. N. V. Bhide, M.Sc. Ph.D.	... 1
II	A Study in the Hydrolysis of the Starches of Some Important Cereals.	Mr. D. N. Godbole, M.Sc.	... 14
III	A Study of Comparative Disintegration of the Constituents of the Grains of Rala and Harik.	Mr. M. V. Sathe, M.Sc.	... 33
IV	A Study of Comparative Disintegration of the Carbohydrates from Dry Fruits.	Dr. R. S. Kale, Ph.D.	... 46
V	Study of the Hydrolysis of Starches Contained in Some Edible Roots and Tubers.	Dr. U. A. Sant, M.Sc. Ph.D.	... 55
VI	The Influence of Some Added Substances on the Hydrolysis of the Starches in Different Flours.	Mr. D. N. Godbole, M.Sc.	... 83
VII	The Effect of Addition of Potassium Chloride and Sodium Chloride on the Hydrolysis of the Flours of Rala and Harik with Diastase at pH 4.1 and Pancreatin at pH 6.8.	Mr. M. V. Sathe, M.Sc.	... 98

CONTENTS

Paper	Title	By	Page
VIII	A Study of Comparative Disintegration of Proteins of the Dry Fruits.	Dr. R. S. Kale, Ph.D.	... 109
IX	Influence of Common Salt (Sodium Chloride) and Vitamins on the Enzymic Hydrolysis of Fats and Proteins.	Dr. R. S. Kale, Ph.D.	... 114
X	A Study of Goat-Milk.	Mr. M. M. Thatte, M.Sc.	... 120
XI	A Study of Sheep-Milk	Mr. P. G. Tulpule, M.Sc.	... 132
XII	A Study of Milk of Ass	Mr. Rajadhyaksha, M.Sc.	... 148
XIII	Comparison of the Composition of Sheep Ghee and Buffalo Ghee.	Mr. P. G. Tulpule, M.Sc.	... 166
XIV	A Comparative Study of Goat-Ghee and Cow-Ghee.	Mr. M. M. Thatte, M.Sc.	... 179
XV	Hydrolysis of a Few Fat-Samples.	Mr. M. M. Thatte, M.Sc.	... 193
XVI	A Study of Ash of Milk and That of Milk-Fat of Ass.	Mr. Rajadhyaksha, M.Sc.	... 211
XVII	A Comparative Study of Some Vegetable Ghees.	Mr. V. S. Kulkarni, M.Sc.	... 22C

CONTENTS

iii

Paper	Title	By	Page
XXVIII	A Comparative Study in the Hydrolysis of a Few Edible Oils with Enzyme Lipase.	Miss S. P. Naegamvala, M.Sc....	249
XIX	A Study of Comparative Disintegration of Fats from the Dry Fruits.	Dr. R. S. Kale, Ph.D. ...	296
XX	Keeping Power of Linseed, Safflower and Cocoanut Oils.	Miss S. P. Naegamvala, M.Sc....	305
XXI	Keeping Power of Groundnut-Oil cake.	Dr. N. V. Bhide, M.Sc. Ph.D. ...	321
XXII	Study in Germination of Oil Seeds.	Mr. J. S. Lilaowala, M.Sc. ...	325
XXIII	Synthesis and Hydrolysis of Esters by Ricinus Lipase.	Mr. C. V. Ramkrishnan, M.Sc. ...	343
XXIV	Study of the Enzymes Present in Germinating Seeds.	Dr. N. V. Bhide, M.Sc. Ph.D. ...	377
XXV	A Study of the Enzymes Present in Germinating Seeds.	Dr. N. V. Bhide, M.Sc. Ph.D. ...	382
XXVI	Studies in the Enzymes During the Period of Germination of the Seeds of <i>Eala</i> and <i>Harik</i> .	Mr. M. V. Sathe, M.Sc. ...	386
XXVII	Study of the Enzyme 'Lipase'.	Mr. J. S. Lilaowala, M.Sc. ...	395

Paper	Title	By	Page
XXVIII	Studies of the Enzymes of the Dry Fruits	Dr. R. S. Kale, Ph.D.	... 421
XXIX	Study of the Amylases from some Edible Roots and Tubers.	Dr. U. A. Sant, M.Sc. Ph.D.	... 426
XXX	Phosphate Supplying Power of some Typical Soils from Western India.	Dr. V. K. Leley, M.Sc. Ph. D....	460
XXXI	A Study of Nitrification of Raw Bone Meal, Bone Grit, Dried Blood, Horn Shavings and Groundnut Cake in Different Soils of Bombay Presidency.	Mr. N. N. Dastur, M.Sc.	... 481



Rao Bahadur Dr. D. L. Sahasrabudhe, D.Sc.

INTRODUCTION

By

RAO BHADUR DR. D. L. SAHASRABUDDHE, D. Sc.

From the analysis of the animal bodies it has been ascertained that the organs consist chiefly of carbon, hydrogen, oxygen, nitrogen and mineral matter. The bones and teeth contain, in addition, calcium and phosphorus in large quantities while the blood also contains iron, sodium and chlorine. The object of food eaten is to supply all these elements to the body in a suitable form.

There are four chief groups of chemical compounds which can supply the requirements of the animal body and therefore constitute the bulk of the body. Three of these groups are (1) carbohydrates, (2) fats, and (3) proteids from which the supply of carbon, hydrogen and nitrogen is chiefly derived while the fourth group consisting of mineral matter provides calcium, phosphorus, sodium, chlorine, iron and a few other elements. It is the proportion of each of these constituents in the food-stuff that is more important than the actual presence of these and this is what an analyst attempts to ascertain, since every food-stuff contains at least a small quantity of each of these. A better judgement of the value of a food-stuff can be obtained if the proportion of the digestibility of the constituents is known.

The object of food is not only to supply material for growth and to replace the waste of the body but the object is also to supply body heat and energy for internal and external work. The energy supplied by the food can be calculated by adding the energy supplied by all the constituents in the food. By actually burning purified constituents in calorimeter the heat-giving or the energy-giving value of each constituent has been determined in calories per gram.

An example may explain this as follows :—

		Small calories	Large calories.
One gram of carbohydrate	...	4,100	4.1
One gram of protein	...	4,100	4.1
One gram of fat	9,300	9.3

If we take wheat-bran we can find out the heat energy supplied by one hundred grams of the material.

TABLE No. 1

	Wheat-bran. per cent.		Large calories in 1 gram of constituent.		Total large calories.
Moisture	... 7.90		—		—
Ether extract (fat)	... 4.00	×	9.3	=	37.20
Albuminoids	... 14.43	×	4.1	=	59.16
Digestible Carbohydrates.	57.02	×	4.1	=	233.78
Fibre 11.85	×	4.1	=	48.58
Total energy in 100 grams of wheat bran					= 378.72

The whole of the total energy shown is not useful to the body as part of the constituent is voided in dung undigested. The energy which is utilised in the body is determined from the digestible material and is called "available energy". In most of the papers included in this publication, this availability percentage of the various food-stuffs studied has been indicated. In Europe and U. S. A. they go even still further and make allowance for that part of the available energy which is utilised in digesting the food itself. We have, however, not gone to that extent and have only determined the availability.

The International League of Food Experts has given that in temperate climate 24,00 large calories of heat and 60 to 70 grams of proteids should be made available to every average man per day. But if the individual is doing work he should get an extra allowance of 150 calories. In India which is a hot country 2200 to 2300 calories of heat are sufficient for an ordinary individual. The usual food-stuffs in common use are

- (1) *Jowar (Andropogon sorghum)*
- (2) *Bajri (Pennisetum typhoideum)*
- (3) *Wheat (Triticum sativum)*
- (4) *Rice (Oryza sativa).*

Some pulses are also used along with these food-stuffs.

If we take one pound of any of these grains we can obtain 1575 calories. This means that in order to obtain 2200 to 2300 calories of heat $1\frac{1}{2}$ pounds of grains is a sufficient quantity of food-stuffs. The quantity of food-stuffs mentioned can supply 67 grams of proteid material. If the grains supplied contain less of proteid material, this deficiency can be made up by the addition of a small quantity of rice-polish or a small quantity of ground-nut cake.

Functions of important constituents:—

(1) **Proteids or albuminoids:**—Proteids or albuminoids occurring in grains, roots and other forms of vegetable food are similar in general composition to those in milk; blood and flesh. From the albuminoids of the blood are formed not only the albuminoids of the animal frame but also the gelatinoids, hair, wool, horn etc., and under some circumstances the fat. By the combustion of albuminoids in the body heat and mechanical force will also be developed. One gram of albuminoids yields 4.1 large calories. Albuminoids thus supply in themselves most of the requirements of the animals—a statement which can be made of no other constituent. The albuminoids of food are frequently described as “Flesh formers”.

An animal even when not increasing in weight, will always require a certain constant supply of albuminoids in its food to replace the waste of nitrogenous tissues which is always going on even during rest. When the nitrogenous tissues of the animal or the albuminoids consumed as food are oxidised in the body, the nitrogen they contain is not burnt but excreted in the form of a nitrogenous substance—urea.

(2) **Fat:**—Fats contained in the food are similar to those found in the animal body. An animal is apparently capable of selecting certain fats in the food for storing up and even of transforming one kind of fat into another. The fat in the food

is either burnt in the animal system or it is stored up as reserved matter. Fat has a greater value as a heat producer than any other ingredient. Its calorific value is 9.3.

(3) **Carbohydrates**:—The carbohydrates of food are chiefly starches, sugars, celluloses etc. Carbohydrates form the largest part of every vegetable food. Carbohydrates are not permanently stored in the animal body but serve for the production of heat and mechanical work. When consumed in excess of normal requirements, they may be converted into fat. 1 gram of carbohydrate gives 4.1 large calories.

(4) **Mineral matter**:—The ash constituents present in the food are the same as those found in the animal body. All that is accomplished by the animal is to select from the digested constituents those of which it is in want. The fact that the ash of feeding stuffs is of great importance to animals is shown by feeding them on mineral-free foods in which case they die of mineral starvation. During such starvation nervous system suffers first. Mineral matter is present in all vital parts. Nuclei of the cells are rich in phosphorus. Bones contain 70 per cent. of calcium phosphate. Blood serum contains sodium chloride and other sodium salts while blood corpuscles contain potassium and iron salts.

(5) **Vitamins**:—In a general way if a human being or any animal is provided with the necessary proteins, mineral matter and calories of heat in the form of carbohydrates and fats he should be able to get along but in the feeding experiments carried on by feeding pure constituents of food to guinea-pigs or rats it was found that the animals suffered in health and they recovered their condition when fed on the quantities of food constituents in the form of ordinary food-stuffs (not purified). For a long time this difference could not be explained but it has now been discovered that the deficiency of vitamins in the purified constituents is at the bottom of the trouble. The vitamins are known as "A", "B", "C", "D" etc. for want of better names. Now a large number of vitamins have come to light and have joined the family and we cannot predict to what extent the number will increase. The vitamins have compelled us to reform our ideas on nutri-

*

tion of adults and babies and we must now pick out our foods with a new angle of vision.

In 1937, a plan was made to start some investigation work on food-stuffs in the chemical laboratory of the Nowrosjee Wadia College. The idea in starting investigation work was to help students going up for the M.Sc. and Ph. D. examinations of the Bombay University by thesis and secondly also to carry on some investigation in which members of the chemistry staff can take part and spend their spare time usefully. It was not possible for each worker to take over full problem and carry it out himself. It was therefore decided to take one problem and carry it out as a team work. The old idea of one man one problem is going in the background and team-work is coming into vogue in most of the laboratories doing research work. In the Wadia College Laboratory the investigation of the proportion of the constituents in the usual food-stuffs consumed in the Bombay Deccan and a relative capacity of these constituents to break down into simpler compounds were considered as important and interesting. It is these simpler compounds that can be absorbed into the human body and the animal body in general, through the valves of the alimentary canal and this is exactly what happens during digestion.

Usually breaking down of the constituents is brought about by hydrolysis. Digestibility of food-stuffs is found out by actually feeding the animals with the food-stuffs to be studied. In Wadia College the investigation work was not conducted in-vivo but in-vitro. There are advantages and disadvantages of the invitro system. The advantages of the in-vivo experiments are that the digestibility is studied by actually feeding animals and determining the proportion of food digested. Since it is done on the living animals there is no reason to doubt in any way the results obtained. On the other hand the experiments done invitro can be carried on under any suitable condition. The temperature, the proportion of reagents, and other conditions can be controlled and the results obtained are always comparable. It was therefore decided to carry on experiments under controlled conditions

in vitro. It would have been better if the results would have been confirmed by experiments in vivo. It is therefore that the results as obtained in the laboratory are placed before the public in the form in which they were obtained.

The following materials were studied. They can be divided into separate groups as:—(i) Cereals (ii) Pulses (iii) Oil seeds (iv) Materials known as dry fruits (v) Ghees—natural and artificial and (vi) Edible oils. Besides these some enzymes also were studied.

The work can be divided according to the reacting agents such as acids, enzymes and so on. The work on enzymes has been dealt with in separate papers. In the animal body it is the enzymes that act as reagents to break down highly complex compounds into simpler ones by their special power of hydrolysis.

In the human body all the enzymes bring about breaking of complex compounds at the body temperature which is about 37°C. and hence all the reactions of the various agents have been worked at 37 degrees centigrade temperature.

The following were the materials (with their botanical names) which were studied in this laboratory:—

- (1) Cereals—(i) *Bajri*—(*Pennisetum typhoideum*).
 (ii) *Vari*—(*Panicum miliaceum*).
 (iii) *Wheat*—(*Triticum sativum*).
 (iv) *Jowar*—(*Andropogon sorghum*).
 (v) *Rajgira*—(*Amaranthus paniculatus*).
 (vi) *Nachani*—(*Eleusine coracana*).
 (vii) *Rala*—(*Sataria italica*).
 (viii) *Harik*—(*Paspalum scrobiculatum*).
- (2) Pulses—(i) *Gram*—(*Cicer arietinum*).
 (ii) *Black-gram*—(*Phaseolus radiatus*).
 (*Udid*)
- (3) Oil seeds:—
 (i) *Linseed*—(*Linum usitatissimum*).
 (ii) *Ground-nut*—(*Arachis hypogaea*).
 (iii) *Safflower*—(*Carthamus tinctorius*).
 (iv) *Cocoanut*—(*Cocos nucifera*).

(4) Materials known as dry fruits:—

- (i) Cashew nut—(*Anacardium occidentale*)
- (ii) Almond—(*Prunus amygdalus*)
- (iii) Pistachio-nut—(*Pistacia vera*)

(5) Roots and Tubers:—

- (i) Carrot—(*Daucus carota*).
- (ii) Sweet Potato—(*Ipomea batata*)
- (iii) Yam—(*Dioscorea alata*).
- (iv) Suran—(*Amorphophallus campanulatus*).
- (v) Potato—(*Solanum tuberosum*)

Taking each group and comparing materials in that group with one another we are able to find out their gradation of breaking down. We can also then compare different groups with one another. In order to explain this treatment more thoroughly we might say that taking the group of cereals we can find out whether rice starch breaks down more easily than *bajri* starch or *jowar* starch and arrange them in order of their power to breaking down. This will be a comparison in the materials in the same group. But now if we take two groups such as cereals and pulses in groups and compare the power of breaking down of the cereals with the power of breaking down of the pulses we can obtain the comparative breaking down of the starches in these two groups.

Along with the food grains a study was made of the hydrolysis of the starches of the materials known as dry fruits. It may be mentioned that edible roots and tubers were also studied as they form an important section of human food materials.

Amongst the various reagents used for the study of starch-hydrolysis hydrochloric acid is the one that is able to break the whole of the starch material and all sorts of carbohydrates into a simple monosaccharose viz. glucose. This gives us the proportion of the total carbohydrates in each material while the action of enzyme gives us the actual amount of carbohydrates available for absorption in the body. The following table gives us the general analysis of the materials studied.

TABLE NO. 2

Material	Moisture %	Ether extract %	Proteins % @	Carbo- hydrate %	Crude fibre %	Ash* %
<i>Bajri</i> ...	7.44	5.66	9.60	74.74	0.92	1.70
<i>Vari</i> ...	10.10	4.36	7.53	70.69	4.62	2.70
Wheat ...	9.97	2.05	11.25	73.66	1.36	1.70
<i>Jowar</i> ...	7.98	3.25	7.83	76.64	1.25	3.05
<i>Rajgira</i> ...	9.35	5.03	15.01	65.72	2.83	2.05
<i>Nachani</i> ...	8.55	1.75	5.71	78.27	2.88	2.84
Gram ...	8.24	4.52	20.03	61.22	3.89	2.10
Black-gram	7.23	2.20	23.21	59.16	3.93	4.27
Cashew-nut	6.00	44.70	21.30	22.40	2.10	3.50
Almond ...	5.90	53.50	20.70	13.40	2.70	3.80
Pistachio ...	5.70	50.70	19.60	18.10	2.80	3.10
Carrot ...	7.70	1.72	4.30	73.20	6.56	6.52
Sweet-potato	7.50	3.90	4.50	78.85	1.75	3.50
Yam ...	8.12	0.27	3.88	82.21	1.48	4.04
<i>Suran</i> ...	8.02	0.31	3.98	77.55	4.10	6.04
Potato ...	7.62	0.11	4.68	79.51	2.88	5.20
<i>Rala</i> ...	9.51	3.64	9.58	74.48	1.36	1.43
<i>Harik</i> ...	9.92	1.87	6.22	80.14	0.75	1.10

@ Proteins are determined by finding out nitrogen and multiplying the figure by 6.25.

* Ash includes sand also.

TABLE No. 3

Disintegration of starches as in flours by 1 per cent. diastase in 3 hours (expressed on the basis of total hydrolysable starch) :

	Material	Starch hydrolysed per cent.	Total hydrolys- able starch %
Cereals :-			
	<i>Bajri</i>	... 45.56	59.82
	<i>Vari</i>	... 49.18	56.23
	Wheat	... 29.81	74.29
	<i>Jowar</i>	... 30.57	77.13
	<i>Rajgrā</i>	... 33.52	59.67
	<i>Nachani</i>	... 34.57	71.67
	<i>Rala</i>	... 39.23	66.83
	<i>Harik</i>	... 35.48	70.52
Pulses :-			
	Gram	... 88.64	42.32
	Black-gram	... 36.60	50.37
Materials known as dry fruits :-			
	Cashew nut	... 30.59	17.34
	Almond	... 23.17	7.78
	Pistachio-nut	... 19.74	6.53

TABLE No. 4

Disintegration of starches as in flours by one per cent. pancreatin in three hours (expressed on the basis of total hydrolysable starch)-

	Material	Starch hydrolysed per cent.	Total hydrolys- able starch %
Cereals :-			
	<i>Bajri</i>	... 55.93	59.82
	<i>Vari</i>	... 50.16	56.23
	Wheat	... 14.58	74.29
	<i>Jowar</i>	... 25.66	77.13

x

<i>Rajgira</i>	...	33.60	59.67
<i>Nachani</i>	...	30.16	71.67
<i>Rala</i>	...	53.54	66.83
<i>Hark</i>	...	43.28	70.52

Pulses :-

Gram	...	50.16	42.32
Black-gram	...	46.44	50.37

Materials known as dry fruits :-

Cashew-nut	...	33.98	17.34
Almond	...	27.12	7.78
Pistachio-nut	...	21.72	6.53

In using food materials human beings take certain salts into their body. It was therefore considered interesting to see whether the salts had any effect on the hydrolysis of food materials.

TABLE No. 5

Effect of common salt on the disintegration of starches by one per cent. diastase in three hours.

Material		Starch hydrolysed (without salt) %	Starch hydrolysed (with salt 0.15 M) %	Total hydroly-sable starch %
<i>Jowar</i>	...	30.57	32.49	77.13
<i>Bajri</i>	...	33.51	33.51	59.67
<i>Nachani</i>	...	34.56	33.92	71.67
Wheat	...	29.86	31.09	74.29

It is seen from these figures that the disintegration of starches is favourably affected in the case of wheat and *jowar* and adversely affected in the case of *nachani* and no effect on *bajri*.

TABLE No. 6

Effect of common salt on the disintegration of starches by pancreatin one per cent. in three hours.

Material	Starch hydrolysed (without salt) %	Starch hydrolysed (with salt 0.15 M) %	Total hydrolysable starch %
Wheat ...	12.15	9.87	74.29
<i>Jowar</i> ...	21.38	26.68	77.13

It is seen from these figures that the disintegration of starches is favourably affected in the case of *Jowar* adversely affected in the case of Wheat.

Milk is intended for the nourishment of newly born animals. If milk is to serve exclusively for nourishing the young, it must of course contain all the nutrients required for the animal organism for its maintenance and growth and there are proteins, fats, carbohydrates and inorganic salts. In addition to these, milk also contains small quantities of various substances known as vitamins which although they possess no direct feeding value have nevertheless an important physiological effect. The milk of all species of animals contains all the constituents mentioned above but the quantities in which they are present vary in different cases.

Ass's milk was studied because it is used for feeding children and is considered to be medicinally good. Its importance to children is due to the fact that it contains a high percentage of sugar and a very low percentage of fat. Children therefore, can easily digest it.

TABLE No. 7.

Composition of milk of different animals.

	Origin	Total solids	Fat	Milk-sugar	Proteids	Ash	Density
Godbole & Sadgopal- (Benares)	Buffalo	18.0 -22.5	3.75 -6.50	5.0 -5.4	5.3 -6.0	0.70 -0.93	1.0320 -1.0420
	Cow	12.9 -14.5	3.00 -3.85	4.5 -5.2	3.4 -4.0	0.45 -0.65	1.0260 -1.0350
Chem. Lab. N. Wadia College	Sheep	14.08 -19.28	4.7 -8.6	3.40 -3.83	4.55 -5.38	0.67 -1.10	— —
	Goat	12.94 -18.28	2.94 -8.15	3.313 -4.606	3.82 -5.11	— —	— —
„	Aus	8.88 -10.26	0.10 -1.48	5.61 -6.58	1.83 -2.15	0.38 -0.52	1.0316 -1.0844

Work on hydrolysis of fats was also carried out. The fats are broken into simple fatty acids.

TABLE No. 8

Hydrolysis of ghees, edible oils, and vegetable ghees with enzyme lipase.

Sample.	Melting Pt. (degrees C.)	Iodine value	Hydrolysis after 48 hours %
Buffalo ghee ...	37.2	28.08	53.20
Sheep ghee ...	29.9	34.75	20.00
Goat ghee ...	23.8	25.87	44.53
Cow ghee ...	39.1	36.64	41.66
Linseed oil ...	solidifies at - 20	165.54	70.00
Safflower oil ...	solidifies at - 18	141.50	23.98
Cocoanut oil ...	25.3	9.96	26.48
Vegetable ghee (A) ...	39.50	65.49	17.99
do. (B) ...	40.2	57.94	17.66
do. (C) ...	39.2	61.10	29.96

If the conditions under which the hydrolysis of fat is carried out are changed then the percentage of hydrolysis is considerably changed.

Proteids:—Proteids are hydrolysed chiefly by two enzymes, namely, pepsin and trypsin. Pepsin acts in acid medium while trypsin acts in alkaline medium. These enzymes do not act on different substances equally well but act more quickly on some than on others. When the seeds of cashew nut, almond, pistachio nut were acted upon by pepsin in acid medium it was found that pistachio nut was acted upon the most while the cashew nut was acted upon the least. While

almond stood between the two. This order of disintegration remained the same when trypsin was used to superimpose pepsin.

Enzymes:—Study of the enzymes was done by different workers in connection with those enzymes with which they had to deal. They studied first of all the proper temperature, pH value, strength and time required for the reaction. The enzymes have a specific action on definite constituents and although two enzymes may act on one and the same constituent yet the conditions under which they work are different such as pepsin and trypsin, although pepsin and trypsin both hydrolyse proteid substance yet pepsin works in an acid medium while trypsin works in an alkaline medium.

Starch is hydrolysed and broken down by amylase. We however find that there are two kinds of enzymes—alpha and beta. The beta amylase works well up to a temperature of 70 degrees centigrade while the alpha amylase works well above this temperature. But it is also found that at a temperature a little below 70 degrees Centigrade and a little above 70 degrees Centigrade, both beta and alpha show some activity and therefore overlap the work of each other.

A general study of the *Ricinus* lipase from castor seed was carried out with a special reference to the nature of the different buffers on the activity and the optimum pH of the *Ricinus* lipase. It was found that optimum pH does not change much but the activity is the highest in acetate buffer. Since the activity of the lipase changes with time, an investigation was carried out in order to find out a modified form of lipase which will keep its activity constant for a fairly long time. It was found that acetone dried lipase keeps the activity constant for a long time and hence it was used for other experiments.

The synthesis and hydrolysis of aliphatic esters of homologous series starting from methyl to amyl butyrate, were carried out. It was found that synthesis increases from methyl to amyl whereas it is reversed in case of hydrolysis. A

distinction was also found between normal and iso forms. It was found that the percentage synthesis or the hydrolysis only depends upon the number of carbon atoms in alcoholic group but not in the acidic group.

The action of different salts was studied on the synthesis and hydrolysis of esters and the salts were divided into three groups as accelerators, retarders and poisons. No definite result had been found as regards the effect of nature of the ions on the synthesis and hydrolysis of esters.

It is a well known fact that the phosphates in the soils form an important plant food material. But the phosphoric acid in the soil is not always available to the plants or it may be available in different degrees. It is therefore important to know what proportion of phosphoric acid in the soil is available to plants. There are different methods by which this can be judged. But there is no method which can be used to give a correct idea of their availability. An attempt was made in the N. Wadia college laboratory to ascertain this. Some typical soils of Bombay Province were obtained and comparative methods of phosphoric acid availability were tried to find out which method gives consistent results and which is yet easily worked out in a laboratory.

Nitrogen is obtained generally from organic materials and only in a few cases from sulphate of ammonia and sodium nitrate. The organic materials which have been tried in the Bombay Province are farm-yard manures, oil cakes, fish and bone-manures. There are substances other than these which are all derived from animals' remnants such as horns, bone-grit and other waste which can be used with advantage as fertilisers but about which nothing definitely is known as to how long they take in disintegrating and making the nitrogen available for plants. An attempt was therefore made by submitting these substances of animal origin mixed with different soils to ascertain as to how long it takes to make the nitrogen available to plants when mixed with different soils of the Bombay Province.
