ANALYSIS OF THREE HYBRID VARIETIES OF WHEAT FOR SELECTED NUTRIENTS

By
Rajakumari, S.

A Dissertation Submitted to the University of Madras
in Partial Fulfillment of the Requirements for
the Degree of Master of Science
April, 1971.

ACKNOWLEDGEMENT

The investigator owes a deep sense of gratitude to Dr. (Mrs.) Janabai Giri, M.A., M.Sc., Ph.D. (Madras), Professor in Bio-chemistry for her consistent and valuable guidance throughout the study. She records her thanks to Dr.(Mrs.) Rajammal P.Devadas, M.A., M.Sc., Ph.D. (Ohio State) for her valuable guidance and suggestions in planning and conducting the study. She expresses her sincere thanks to the Wheat Breeding Station Officer, Wellington, for providing the samples.

LIST OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

LIST OF APPENDICES

I. INTRODUCTION

"Wheat is the food of the world" and its cultivation antedates history. Today it is cultivated throughout the world (Technical Report Series, 1965). The recognition of wheat as a valuable supplement to the rice diet and extensive campaign to eat more wheat have resulted in a considerable increase in the consumption of wheat in South India in the past few years.

From time immemorial wheat has been the staple crop for millions of people all over the world. (Austin et al , 1968). Sukhatme (1971) estimates that cereals contribute 58 to 70 per cent of the total calories and 60 per cent of the protein supply in South East Asian regions. The major cereals consumed in India are wheat and rice (Pant, 1970).

Shastri (1965) exhorts that our long term objective must be to achieve self sufficiency in food, not by self denial but by growing two grains, where only one grew. Devadas (1967) stresses that efforts need to be directed on global and national scale to make available at little or no cost, more foods to the masses, through evolution of new species and strains of food crops. Research workers have to concentrate in developing suitable methods to maintain the nutritional quality of food (Venkatachalam, 1967).

The development of high yielding strains of food grains has now been accepted as a major item in the agricultural policy in our country for increased production (Mishra and Deosthale, 1969). The "Green Revolution" aimed at developing high yielding strains of food grains has gained considerable momentum all over the world. In order to overcome the food deficit, and also to meet the increased demand food grains are being evolved and some of the varieties like Sharbati Sonora, Kalyan Sona and Chhotilerma are being released for large scale cultivation (Joshi, 1968). These varieties are expected to step up the yield from one ton/ hectare to eight tons/hectare. This is the "Agricultural Revolution" that is sweeping the country (Gopalan, 1970).

While increased yields and other agronomical and economic considerations are important the nutritional aspects should also be an important consideration in the programme for evolving new varieties from the public health point of view. Especially in the case of cereals, which form the bulk of the diet in our country it should be ensured that the nutritive value of the grain is not in any way impaired, because even small changes in the

nutrient composition can affect profoundly the over all nutritional quality of the highly cereal based diets (Ramasastri and Srinivasa Rao, 1969). This study is hence directed to obtain the nutrient composition of three high yielding varieties of wheat, H.W. 109, NP. 202 and Lalbahadur which have been recently evolved.

II. REVIEW OF LITERATURE

The literature pertaining to this study on the "Analysis of three hybrid varieties of wheat for selected nutrients" is reviewed in the following sequence:

1. Wheat production in India and the world
2. Place of wheat in the Indian dietaries
3. Nutritive value of wheat
   a. Protein and amino acids
   b. Carbohydrates
   c. Minerals

and d. Vitamins.

II. Effect of hybridisation on the nutritional qualities of wheat

1. Wheat production in India and the World

In India the "Active Wheat Revolution" started in the year 1966. Through the assistance of the Rockefeller Foundation, many wheat varieties developed in Mexico are now being used extensively in India, Pakistan and other countries. As a result, production of wheat in India has been steaily increasing from year to year. During the period 1955-1970, the production of wheat has been stepped up from 11,213,000

tons to 18,329,000 tons (Directorate of Economics and statistics, 1965; Grain Bulletin, 1970). The import of wheat in India during the period of 1-1-'70 to 28-2-'70 amounted to 8,21,903 tons (Agricultural Situation in India, 1970). Kishen and Lakhanpal (1969) are of the opinion that though the cultivation of cereals like wheat, rice, jowar etc. occupies about 80 million hectares, yet the production will not be enough to meet the pressing demand of the growing population. Austin et al (1968) estimates that among the cereal crops wheat has occupied a major acreage in our country.

The following table gives an idea of the production of wheat in the different countries of the world. (Bulletion of Grain Technology, 1970):

TABLE I

WORLD WHEAT PRODUCTION

Name of the country	1967-68	1968-69	1969-70
Austria	7,427,000	14,570,000	10,982,000
Canada	15,882,000	17,407,000	18,357,000
India(b)	11,213,000	16,279,000	18,359,000
United Kingdom	3,841,000	3,414,000	3,320,000
Pakistan (b)	4,324,000	6,375,000	6,605,000
France	14,062,000	14,748,000	14,305,000
West Germany	5,727,000	6,101,000	5,905,000
Italy	9,444,000	9,503,000	9,386,000
Greece	1,985,000	1,536,000	1,742,000
Spain	5,561,000	5,288,000	4,575,000
Yugoslavia	4,744,000	4,294,000	4,811,000
Soviet Union	76,196,000	91,198,000	--
United States	40,778,000	42,221,000	39,070,000
Argentina	7,204,000	5,649,000	6,623,000
North Africa	2,860,000	4,935,000	--
Turkey	9,950,000	9,450,000	8,269,000

b. These crops are harvested in the early months of the calender years.

2. Place of Wheat in the Dietary:

The universal acceptability of wheat, its potential large-scale availability, and its digestibility have earned for the cereal a major consideration in programmes designed to combat malnutrition (George et al, 1969). Cereals form a major part of the dietary of the people constituting as much as even 75 per cent by their bulk and contributing a significant amount of protein. In the Asian dietaries, cereal grains supply 67 per cent of the food caloric intake and about 60 per cent of the protein intake (Sukhatme, 1971). Cereals such as wheat, rice and millets occupy a predominant position in the diet of the Indians (Gopalan et al, 1969). Balasubramaniyan (1952) states that in an average Indian diet, wheat gets the position next to rice. The Punjab, Haryana and Madhya Pradesh are the three main wheat consuming areas in India. (Diet Atlas of India, 1969; Swaminathan and Bhagavan(1964).

The following Table (Diet Atlast of India, 1969) illustratesthe point.

TABLE II

AMOUNT OF WHEAT CONSUMED IN DIFFERENT STATES OF INDIA - PER PERSON PER DAY

State	Amount (g)
Andhra Pradesh	9
Bihar	49
Gujarat	13
Himachal Pradesh	124
Jammu and Kashmir	18
Kerala	27
Madhya Pradesh	355
Maharashtra	58
Mysore	16
Punjab and Haryana	393
Rajasthan	181
Tamil Nadu	10
Uttar Pradesh	143
West Bengal	61

For many countries, wheat forms the staple food and gives more than 40 per cent of the total calories. Table III gives the list of the countries which derive more than 40 per cent of the total calories from wheat.

TABLE III

Country	g. of wheat per caput daily	% of total calories from wheat
Turkey	516	58
Yugoslavia	416	48
Greece	404	48
Hungary	363	42
Italy	331	42
Afganistan	325	55
Iran	321	55
Syria	313	47
Jordan	310	50
Chile	300	44
Lebanon	282	44
Iraq	259	42
Libya	229	44

Atta, maida and suji are the main forms in which wheat is consumed in India. Flour is the general name given by the miller to the milled endosperm containing variable amounts of bran. Suji is the endosperm of the wheat. Another form of wheat product which is of great interest to humanity is Bulgar wheat. It is believed that the Hebrew Word "Arisah" which appears twice in the Bible (Nehamiah 10-37, Ezekiel, 30-44) and is translated in King James Version as,

"Dough", and in the recent version as "coarse meal", refers to Bulger wheat. Traditionally Bulgar is made by boiling the whole wheat and then cracking it between the stones. Bulgar is a product which resembles in its nutritional properties of whole wheat more closely than refined white flour. It has therefore been produced on an increasing scale, particularly for the supplementary feeding programmes and distribution through Relief Organisations in various countries (Aykroyd and Doughty, 1970).

In India, wheat flour is used to prepare many sweet and savoury dishes. Wheat is used widely also for preparing chapati, puri, rava, iddli, wheat halwa, parota, uppuma, pittu and kesari. Apart from these preparations, wheat flour is also used for preparing porridge, cakes, biscuits, bread and other confectionaries. Among all the prepar ations made out of wheat flour, chapti, constitutes and commonest preparation (Patwardhan, 1952). Using the wheat flour with other ingredients like lentil dhal and jaggery an infant weaning food is prepared (Pasricha, 1969).

3. Nutritive value of Wheat:

The nutritive value of wheat depends on many factors such as the strain, growing and harvesting season, climate, fertiliser and rotation of crops (Mirchandi et al, 1968). The quality characteristics are determined

by nitrogen manuring, irrigation, variety, time of sowing, soil and climate (Banerjee and Swaminathan, 1966).

Cereals are generally characterised by a high calorie content, substantial protein, as well as fair amounts of the vitamins of the B group and minerals especially in the whole or undermilled state (Rao, 1970). Some of these nutrients such as thiamine, riboflavin, are liable to be lost in milling (FAO, 1954). Investigations carried out by McCance et al (1945) and Mortan and Morris (1945) showed that milling of wheat resulted in a considerable loss of proteins, B complex vitamins and minerals. The higher the degree of milling the greater was the loss of different nutrients. However, milling of wheat was also found to have some beneficial effects, as it reduces the fibre phytate and phosphorus contents which interfere in the utilisation of the protein and calcium respectively.

A grain of wheat consists of three parts, namely the bran, the germ and the starchy endosperm. The endosperm normally represents about 85 per cent of the grain and the germ 25 per cent, although the proportions vary in different types of wheat.

Protein:

In many areas of the world, wheat is the major source of protein in the diet (Mattern et al, 1968). The Principal protein in wheat is gluten, which is the

chief ingredient responsible for the unique ability of wheat flour to form the well known leavened bread structure (Braveman, 1963). Investigations carried out by Hutchinson and Martin (1970) prove that the outermost layers of bran of wheat grain, ie. its pericarp with testa and aleurone attached together account for some 15 per cent of its nitrogen, mainly as proteins.

Indian commercial wheat which used to be exported to the United Kingdom before the First World War, when India had a good export market for her wheat, contained low protein which did not exceed 10 per cent. But now as a result of wheat improvement work carried out in India during the past five or six decades, great progress has been achieved in improving the protein content of the grains (Kent, 1957). Upreti and Austin (1969) claim that a few years back the highest protein content was only about 12.2 g. per cent but due to the improvement in the seed quality, the protein content has been markedly increased and varieties like Sharbati Sonora, contain nearly 17 per cent protein. Fifty lines of wheat varieties of Indian and foreign origin were investiaged for their protein content by Deosthale et al, 1966. The protein content of these lines varied from 8.6 to 16.9 g. per cent.

Amino Acid Composition of Whole Wheat and Flour:

The FAO (1970) has compared the amino acid content of whole wheat, and wheat flour at different extraction rates with the amino acid composition of whole egg as shown in Table IV.

TABLE IV

AMINO ACID COMPOSITION OF WHEAT FLOUR AT DIFFERENT EXTRACTION LEVELS

Amino Acid	Whole wheat	Wheat flour at different extraction levels			
		90 - 80%	80 - 70%	70 - 60%	Whole egg
	mg / g of total nitrogen				
Arginine	288	259	221	193	381
Histidine	143	121	130	121	1 52
Lysine	174	159	130	113	436
Leucine	417	379	440	400	551
Isoleucine	204	232	228	217	393
Methionine	94	97	91	87	210
Cystine	159	127	159	142	152
Phenyl alanine	282	276	304	291	358
Tyrosine	187	186	145	132	260
Threonine	183	192	168	153	320
Tryptophan	68	68	67	57	93
Valine	276	270	258	240	428

Pant (1970) has analysed the lysine content of six varieties of wheat namely Lerma Roja, Sonora 64, Sharbati Sonora, Kalyan Sona and Safed Lerma and found that they contained 2.5, 2.9, 2.4, 2.4, 2.7 and 2.5 g/100 g protein respectively.

Experiments with rats suggested that the protein in wheat is inferior to animal protein for both growth and maintenance, because lysine, the essential amino acid necessary to promote growth is the primary limiting amino acid in wheat followed by threonine (Boturichi et al, 1968). Peterson (1965) has analysed the amino acid composition of various parts of wheat which is presented in Table V.

TABLE V

ESSENTIAL AMINO ACID COMPOSITION IN WHEAT PROTEIN CALCULATED, TO 16 PER CENT NITROGEN ON MOISTURE AND ASH FREE BASIS

Amino Acids	Inner endos-perm %	Outer endos-perm %	Bran %	Germ %	Whole Wheat %
Arginine	2.92	4.50	7.53	6.23	3.81
Histidine	1.65	1.74	1.68	3.03	1.65
Iso-leucine	7.02	6,56	4,50	5.23	6.97
Leucine	9.14	7.98	6.52	7.33	8.27
Methionine	1.12	1.40	1.09	1.208	1.32
Phenyl alanine	3.95	3.43	2.45	2.47	3.68
Threonine	-	2.56	2.72	2.85	6.28
Valine	3.65	4.02	4.10	4.20	4.00
Lysine	1.92	2.60	3.87	5.44	2.80

Aykroyd and Doughty (1970) state that high protein wheat in general, includes larger quantities of the proteins forming gluten which is rich in the non-essential amino acid glutamic acid, but poor in lysine. Low protein wheat on the other hand contains less gluten but proportionately more soluble protein with higher lysine content. However, Swaminathan (1971) says that in crops like wheat, increased protein content does not lead to reduction in the quantity of lysine upto a certain point.

Carbohydrate:

Swaminathan and Bhagavan (1964) observe that the whole wheat flour contains about 71.2 g. of carbohydrate 100 g. flour. According to ICMR (1969), whole wheat, whole wheat flour and wheat flour refined contain 65.9, 71.2 and 73.9 g per cent respectively.

Minerals:

Upretty and Austin (1970) conducted a comparative study of the chemical composition of Sonora 64 and Sharbati Sonora. Their result indicates that Sharbati Sonora has a high total phosphorus content of 0.736 g/100 g of flour, while Sonora 64 has a phosphorus content of only 0.595 g/100 g. of flour. The ICMR, (1952) figures for the mineral content of the endosperm and the germ, are given in Table VI.

TABLE VI

Minerals	Whole wheat	Endosperm Central Portions	Germ Outer-layers	Germ Embryo
Phosphorus mg/100g	213.0	59.0	1017.0	1160.0
Iron mg/100 g	3.0	0.5	120.0	9.0
Phytate phosphrous mg/100g	311.0	8.0	874.0	40.0

According to the FAO (1970) the calcium content of the wheat flour is 37 mg and iron is 4.1 mg/100g and the phosphorous content is 320 mg/100 g.

Vitamins:

Wheat is one of the good sources of the B complex vitamins. Therefore Passmore and Sundararajan (1941) advocated the inclusion of some whole wheat in the diet of consumers of raw milled rice to prevent beriberi. Heath (1969) says that ordinary wheat flour and products made from it are still important sources of protein, calcium, iron, thiamine and nicotinic acid in an average diet. Although not a first class source of any particular nutrient, bread made out of wheat supplies a significant portion of the nutrients required for growth and maintenance of health and well being. Tara et al (1966) have stated that "Atta" a by product of roller flour milling has an important feature in having a high thiamine content of 0.41mg/100g. According to the ICMR(1966) the nicotinic acid content of whole wheat is 4.3 mg/100 g.

According to the FAO 100 g of whole wheat flour contains of 0.45 mg thiamine, 0.13 mg of riboflavin and 5.4 mg of nicotinic acid .

Effect of Hybridisation on the nutritional qualities of wheat:

The ultimate aim of the hybridisation is to improve the quality and to increase the yield. New techniques are being evolved to improve the nutrient content of the grains. Techniques like, irradiation, mutation and increased application of fertilisers are widely accepted methods. Sanghi et al (1960), found that gamma irradiation raised the protein content from 14.82 to 16.02 per cent in a variety called Lutescens 62. Similarly, the large dosage of fertiliser also has a significant effect on the nutritive value of the grains. Bharagava and Motiramani (1970) investigated the effect of increased application of ammonium sulphate, and concluded that the large dosage of fertilisers significantly increased the nitrogen, calcium, and magnesium contents at all three stages of growth namely, tillering, flowering and harvesting. Application of nitrogen increases the yield and among the quality characters sutdied, nitrogen application resulted in significant increases in protein, calcium and magneisum contents of grains (Garg and Tomaria, 1970; Mcpherson, 1970). Similarly, the total production of protein and lysine per level of nitrogen application

on the variety Lerma Rojo was studied. The conclusion was that the lysine content was 11.14 and protein was 393.47 kg/ hectare under 120 kg of nitrogen fertilisation, where as under no nitrogen application, the production was only 157.53 kg. protein and 4.85 kg. lysine. (Austin et al, 1969).

III. EXPERIMENTAL PROCEDURE

The experimental procedure followed for the study on the "Analysis of three hybrid varieties of wheat for selected nutrients" are discussed under the following sequence:

A. Selection of the strain

B. Preparation of the sample

C. Nutrient analysis.

A. Selection of the strain:

Hybrid Wellington 109 (H.W. 109), New Pusa 202 (N.P. 202) and Lalbahadur were selected for the analysis of nutrients because preliminary studies with these hybrid varieties demonstrated a high protein content. Further, the yield potential of H.W. 109 is greater than that of the ordinary variety and it is considered to be very good for South Indian conditions. As for N.P. 202, it is fairly resistant to rust and also has a good amount of protein. Lalbahadur is expected to flourish in the sandy soils of Rajasthan. This strain has one major advantage over the other Mexican varieties, in having a large amber coloured lustrous kernel, as in the traditional Indian varieties, and as such it is felt that it would be highly acceptable in India. Hence it was of interest to analyse the nutrient contents of the three

hybrids H.W. 109, N.P. 202 and Lalbahadur. The other particulars regarding these hybrids are given below:

Hybrid Wellington.109

(Triticum aestivium variety) Hexaploid.

Parentage - E 4928 x Sonalika (S.308)

Grain Size - 44g/1000 grain weight

Yeild potential - 50-60 quintals/ha under high fertility conditions

It is highly responsive to fertilisers.

N.P. 202

(Triticum dicoccum variety) Tetraploid.

Parentage (E 2025 x IC 1057) x (E 2774 x N.P.200)

Grain size - 42g/1000 grain weight.

Yield potential -

15-20 quintals/ha under rain fed conditions.

8-10 quintals/ha with irrigation.

Fairly resistant to result and highly suitable for the purposes of preparing rawa and suji.

Lalbahadur:

(Triticum aestivium variety) Hexaploid

Parentage - (S54723 x RS 31-1)

Grain Size - 24.5g/1000 grain weight.

Yeild potential - 8.0quintals/ha

This variety being a 3 gene dwarf there is no lodging.

B. Preparation of the Sample:

Grain samples of three hybrid varieties of wheat were collected from the wheat breeding station at Wellington, Nilgirls district and dried in the Sun. To avoid mixing with other flours in the flour mill, the wheat samples were ground with the help of a stone grinder and passed through a 40 mesh separately.

About five g of the sample were taken for the analysis of all the nutrients except protein for which 250 mg were taken. The samples were digested by the "Wet Digestion Method" and the digested solution was used for the estimation of calcium, iron and phosphorus.

For each variety, three aliquot samples were taken. For each aliquot analysis of the nutrients were done in triplicates to get a reliable data.

C. Nutrient analysis of the samples:

The three varieties of wheat samples were analysed for the following nutrients:

Proximate principles:

Among the proximate principles moisture, ash and protein contents were analysed.

Moisture and ash:

Moisture was measured by drying weighed portions of the sample to constant weight in an oven at 98 - 100°C. Ash content was estimated by the method recommended by the A.O.A.C. (1960).

Protein:

Protein was estimated by microKeldahl method recommended by Hawk et al and the conversion factor 6.25 was used.

Minerals:

The ash solution of the samples prepared by wet digestion was used for the estimation of calcium, iron and phosphorus.

A. Calcium:

Calcium was estimated by the titrimetric method recommended by the A.O.A.C. (1960) and modified by the National Institute of Nutrition (NIN). (Appendix - I).

B. Iron:

Iron was estimated usingthe colorimetric method of Wong as described by Hawk et al (1965).

C. Phosphorus:

Phosphorus was analysed by the Hydroquinone method, as recommended and modified slightly to suit the laboratory conditions, by Ramasastry (1969). (Appendix II).

D. Phytates:

Phytin phosphorus, which is extracted with dilute HCl precipitated as ferric phytate with a known amount of ferric chloride and the excess determined colorimetrically as thiocyanate (Sundararajan, 1938). (Appendix-V).

3. Vitamins:

Riboflavin, thiamine and niacin contents were analysed in the three hybrids.

a. Riboflavin:

For the determination of riboflavin content of wheat flour, the extraction method was employed with known weights, followed by the flurometric determination of the extracts. The method followed for the fluorometric determination of the extracts was that of Hawk et al (1965).

b. Thiamine:

Thiamine was estimated by the thiochrome method of A.O.A.C. modified (for cereals) by the Central Food Technological Research Institute. (Appendix III).

C. Niacin:

For the determination of niacin, known weights of the samples were hydrolysed. This brought about complete hydrolysis of the coenzymes, nicotinamide and nicotinic acid but with no conversion of the inactive trigonelline and very small amount of interfering substances. Niacin was then reacted with cyanogen bromide to give a pyridine compound. The niacin content was measured by the density of the colour of the compound in a photoelectric colorimeter using 420 mμ. filter (Sundaram and Sarma, 1957) (Appendix IV.).

IV. RESULTS AND DISCUSSION

The findings of this present study are discussed under the following headings:

A. Proximate principles:

a. Moisture
b. Ash
and c. Protein

B. Minerals

a. Calcium
b. Iron
c. Phosphorus
and d. Phytate

C. Vitamins

a. Thiamine
b. Riboflavin
and c. Nicotinic acid

A. Proximate principles:

The Table I gives the moisture content of the three samples, each expressed as percentage on fresh weight basis. The values are averages of three replicates. The details of statistical analysis are given in Appendix VI.

TABLE I

THE MEAN MOISTURE CONTENT OF H.W. 109, N.P. 202 AND LALBAHADUR IN g PER CENT

Variety	Moisutre content Mean ± S.D.	Varieties compared	't' value
H.W. 109	10.52 ± 0.3	H.W.109 Vs N.P.202	1.3
N.P. 202	11.17 ± 0.6	N.P.202 Vs Lalbahadur	4.22*
Lalbahadur	9.92± 0.4	N.P. 202Vs H.W. 109	1.9093

* Significant at 5 per cent level

The three varieties exhibited considerable variation in their moisture contents. The results from 10.52 to 13.80 g per cent. Among the three varieties N.P. 202 contained the highest moisture content of 11.16 g per cent, and Lalbahadur the lowest. The moisture content of all the three varieties is lower than the value specified by ICMR (1966) for moisture content of whole wheat flour which is 12.2 g per cent.

FIGURE 1

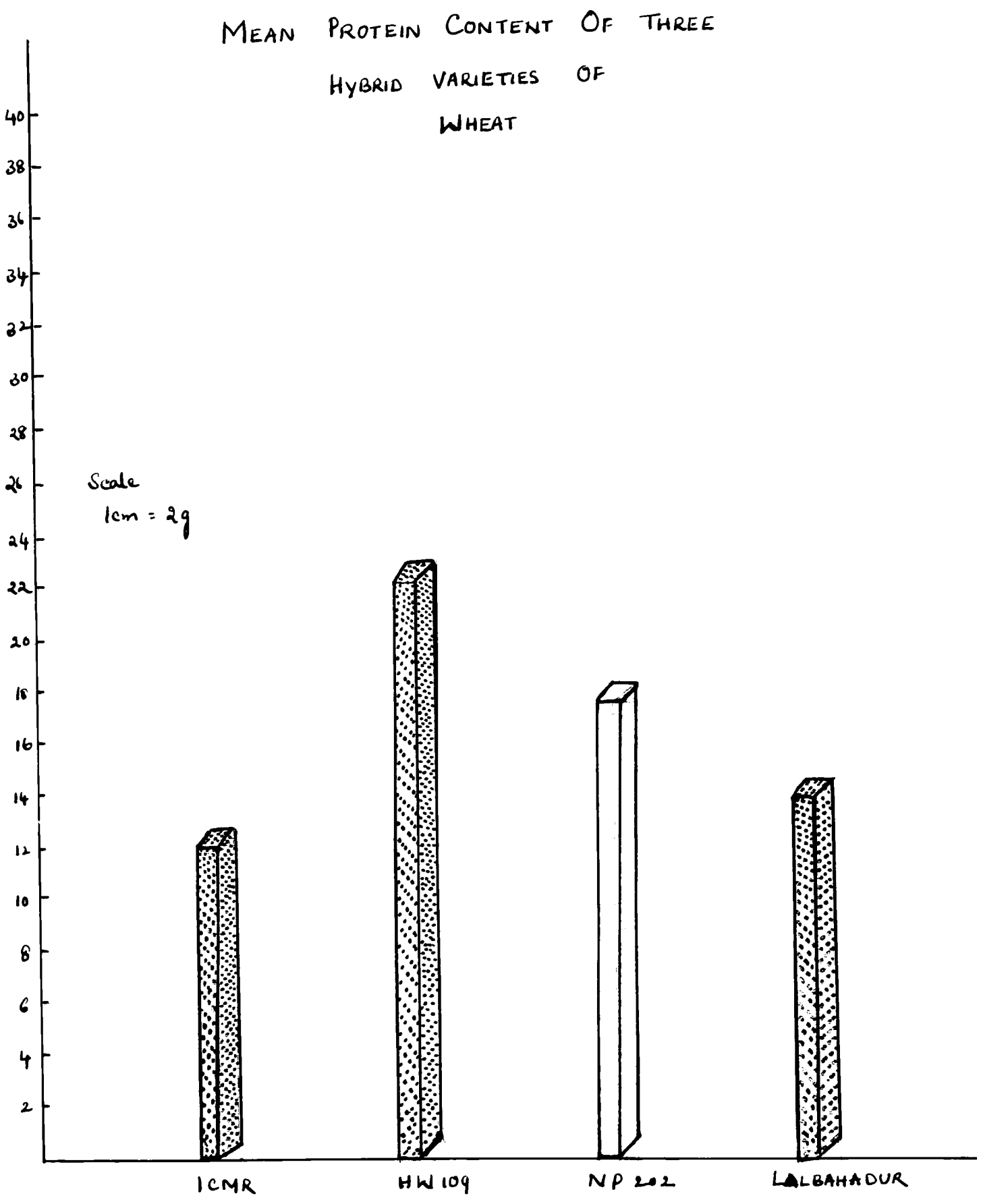

MEAN PROTEIN CONTENT OF THREE HYBRID VARIETIES OF WHEAT
40
38
36
34
32
30
28
26
24
22
20
18
16
14
12
10
8
6
4
2
Scale
1cm = 2g
ICMR
HW 109
NP 202
LALBAHADUR

Table II gives the mean ash content of the three hybrid varieties of wheat. The details regarding the replicate values and the statistical appraisal are given in Appendix VII. The range of variability for ash content was from 1.42 to 1.83 g per cent. Lalbahadur contained the highest ash content. This may be due to the highest calcium and phosphrous content of Lalbahadur. (Tables IV and VI). The ash content of H.W. 109 was very low compared to the ash content of the other two varieties (The value specified by ICMR for local variety is 2.7 g.). Thus the ash content of all the three varieties of hybrids were lower than the values given by the ICMR.

TABLE II

THE MEAN ASH CONTENT OF H.W. 109, N.P. 202 and LALBAHADUR
g./100 g of flour

Variety	Ash Mean ± S.D.	Varieties compayed	't' value
H.W. 109	1.42 ± 0.13	H.W. 109 Vs. N.P.202	0.03430
N.P. 202	1.62 ± 0.1	N.P. 202 Vs. Lal-bahadur	0.01170
Lalbahadur	1.83 ± 0.13	Lalbahadur Vs. H.W. 109	0.01659

Data on the protein content of the three hybrid varieties of wheat are presented in Table IIIa. The details regarding the replicated values and the statistical appraisal are given in Appendix IX.

TABLE III (a)

THE MEAN PROTEIN CONTENT OF H.W. 109, N.P. 202 and LALBAHADUR

(g/100 g flour)

Variety	Protein Mean ± S.D.	Varieties compared	't' value
H.W.109	20.16±0.7	H.W.109 Vs. N.P.202	4.699**
N.P.202	17.26 ± 0.4	N.P. 202Vs. Lalbahadur	3.4833*
Lalbahadur	13.77±0.2	Lalbahadur Vs.H.W.109	6.037**

** Significant at 1 per cent level

* Significant at 5 per cent level.

The protein content of the three varieties ranged from 13.77 g. to 20.16 g/100 g. of whole wheat flour. These values were higher than that of the other hybrid vaieties reported by different workers as shown in Table III (b). The statistical analysis shows that the difference in protein content between H.W. 109 and N.P. 202 is significant at 1 per cent level. The difference netween N.P. 202 and Lalbahadur is significant at 5 per cent level and the difference between Lalbahadur and H.W. 109 is significant at 1 per cent level.

Data on the protein content of the three varieties compared with the other hybrid varieties and the ICMR value are presented in Table III (b).

TABLE III (b)

THE MEAN PROTEIN CONTENT OF THE THREE HUBRIDS Vs. OTHER HYBRIDS

H.W.109	N.P.202	Lalbahadur	Sharbati Sonora	Sonora 64	Lerma Rojo	N.P. 879	ICMR value
20.20	17.26	13.77	16.2	13.0	15.4	14.6	12.1

The variety H.W. 109 is found to be superior not only to N.P. 202 and Lalbahadur, in protein content, but also to other well known hybrid varieties like Sharbati Sonora, Lerma Rojo and N.P. 879.

N.P. 202 has more protein content than all the other varieties compared, except H.W. 109.

Though Lalbahadur has a lesser protein content than all the hybrid varieties compared, except Sonora 64, it has a higher protein content than the ICMR (1966) value which is 12.1 g/100 g flour. Thus these values corroborate with the report of Ramasastry and Pant (1970) that the hybrid varieties of wheat contain larger amount of protein than the local varieties.

B. Minerals:

Table IV indicates the mean calcium content of the three varieties. The details of the replicate values andthe statistical appraisal are given in appendix X. Figure 2 represents the calcium, iron, and phosphorus pattern of H.W. 109, N.P. 202 and Lalbahadur.

TABLE IV

THE MEAN CALCIUM CONTENT OF H.W. 109, N.P. 202 AND LALBAHADUR(mg/100g) OF WHOLE WHEAT FLOUR

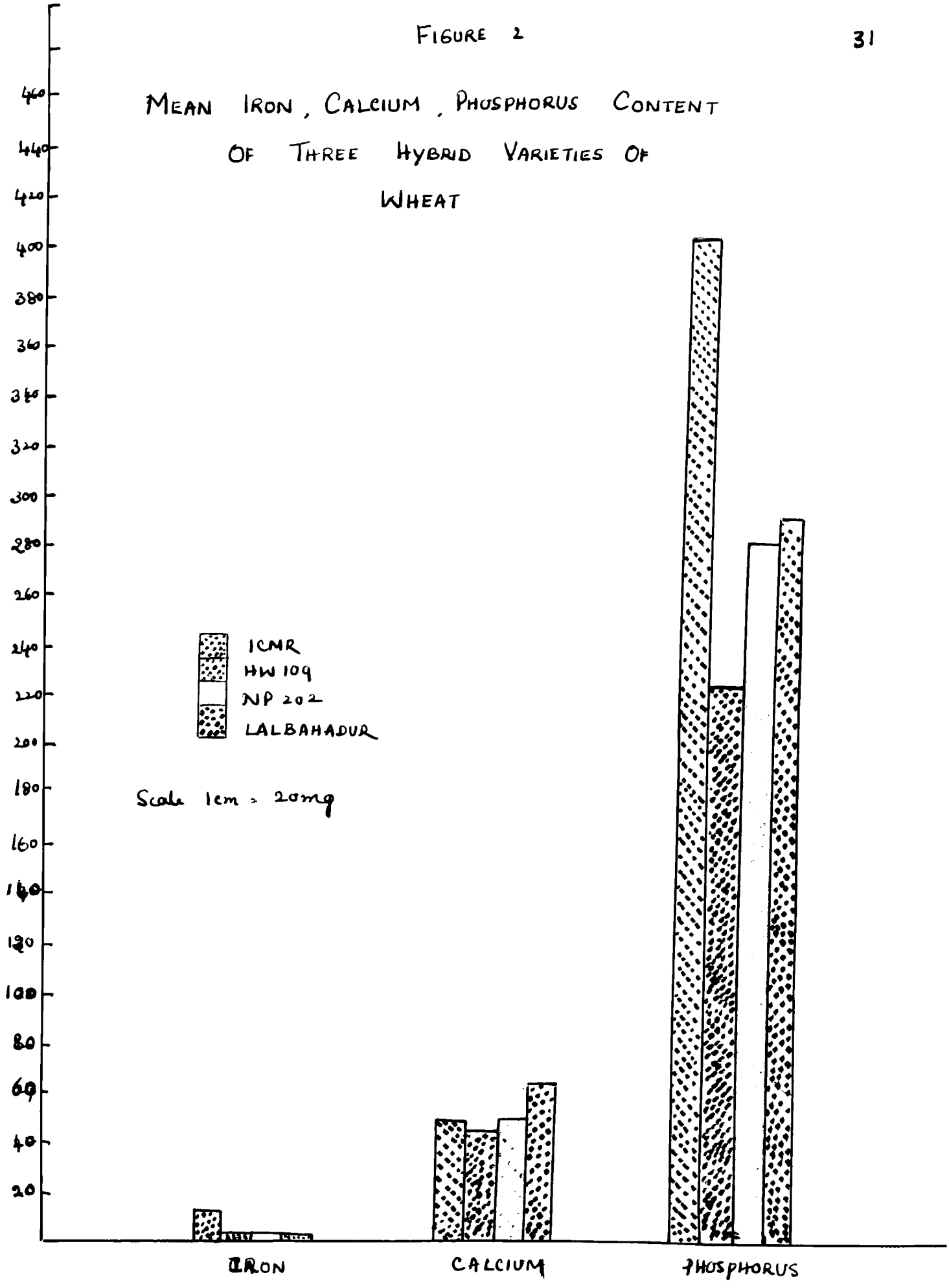
Variety	Calcium Mean ± S.D.	Sources of comparison	't'value
H.W. 109	46.9 ± 0.56	H.W.109 Vs. N.P.202	23.52**
N.P. 202	52.54± 0.8	N.P.202 Vs. Lalbahadur	11.584**
Lalbahadur	66.87± 1.5	Lalbahadur Vs. H.W.109	16.80**

** Significant at 1 per cent level.

The three varieties varied considerably in their calcium content, range being 46.91 to 66.87 mg. per cent. H.W. 109 had the lowest calcium content while Lalbahadur had the highest. Krishnamurthy (1968) states that as the protein content increases, the calcium content will decrease. The results of the present study agree well with the above findings. The sample H.W. 109 had the highest protein

FIGURE 2

MEAN IRON, CALCIUM, PHOSPHORUS CONTENT OF THREE HYBRID VARIETIES OF WHEAT



content, while its calcium content was the lowest. On the other hand Lalbahadur contained the highest calcium, but the lowest protein content.

According to the ICMR (1966), the calcium content of the wheat flour is 48 mg./100g. Hence these findings prove that the calcium content of N.P. 202 and Lalbahadur is higher than that given by ICMR (1966).

Table V gives the iron content of the three hybrid varieties of wheat. Details of replicate values and statistical analysis are given in Appendix XI. Fig 2. represents graphically the iron content of H.W. 109, N.P. 202 and Lalbahadur.

TABLE V

THE MEAN IRON CONTENT OF H.W. 109, N.P. 202 AND LALBAHADUR mg/100 g. FLOUR

Variety	Iron	Varieties compared	't' value
H.W. 109	2.082±0.22	H.W.109 Vs.N.P.202	0.2842
N.P. 202	2.062±0.096	N.P.202 Vs.Lalbahadur	2.702
Lalbahadur	1.780±0.10	Lalbahadur Vs.H.W.109	3.837*

* Significant at 5 per cent level.

The value reported by the ICMR(1966) for the iron content of wheat is 11.5 mg/100 g of flour. The great difference between the ICMR value and the values presented in Table V may be due to the difference in soil, climate, fertilisation level etc. (Banerjee 1967). However, the

data reported by Kent Jones (1967) is 0.5 to 2.8 m/100g agree with the findings of the present study.

Table VI presents the phosphorus content of H.W. 109, N.P. 202 and Lalbahadur. The details of statistical analysis are given in Appendix XII. Fig. 2 represents diagrammatically the mean phosphorus value of the three hybrids.

TABLE VI

MEAN PHOSPHORUS CONTENTS OF THE THREE HYBRID VARIETIES (mg/100g)

Variety	Phosphorus Mean ± S.D.	Varieties compared	't' value
H.W.109	220.8±1.3	H.W.109 Vs N.P. 202	19.43**
N.P.202	280±4.3	N.P.202 Vs Lalbahadur	3.306*
Lalbahadur	290.26±0.73	Lalbahadur Vs H.W.109	18.48**

*Significant at 5 per cent level.
**Significant at 1 per cent level.

Lalbahadur had the highest phosphorus content, while H.W.109 had the lowest. But all the three varieties have must lower value than the local strains which is 423mg/100g flour, according to ICMR(1966). However, Swaminathan and Bhagavan (1964) working with the local wheat variety have reported only a value of 0.320mg/100 flour. Compared to this value, the phosphorus values of H.W. 109, N.P. 202 and Lalbahadur are not strikingly low.

However, all the three had lower values than that reported by Swaminathan and Bhaqavan (1964).

Table VII presents the calcium-phosphorus ratio of the three hybrid varieties.

TABLE VII

THE CALCIUM PHOSPHORUS RATIO OF H.W. 109, N.P. 202 AND LALBAHADUR

Variety	Mean calcium mg%	Mean phosphorus mg%	Ca:P
H.W. 109	46.91	220.8	1:5
N.P. 202	52.54	280.0	1:5
Lalbahadur	66.87	290.26	1:4

The calcium phosphorus ratio of H.W. and N.P. 202 is 1:5 while that of Lalbahadur is 1:4. According to Beaton and Mchenry (1966) the ideal Ca:P ratio in a diet is 1:4. This ratio is very important in the obsorption and utilisation of calcium, phosphorus and iron as well as in calcium and iron metabolism, where in the Ca/P ratio has more influencing action than the phytate content. Robert et al (1954).

Data on the phytate content of the three hybrid varieties are presented in Table VIII. Details of replicate values and the statistical analysis are presented in Appendix XIII. The phytate content ranges from 166.66 to 208.53 mg. per cent.

TABLE VIII

MEAN PHYTATE CONTENT OF H.W.109, N.P.202 AND LALBAHADUR (mg/100g OF FLOUR)

Variety	Phytate Mean ± S.D.	Varieties compared	't'value
H.W. 109	208.53±1.6	H.W.109 Vs.N.P.202	17.35**
N.P. 202	166.66±2.9	N.P.202 Vs.Lalbahadur	17.25**
Lalbahadur	208.33±2.9	LalbahadurVs H.W.109	1.9

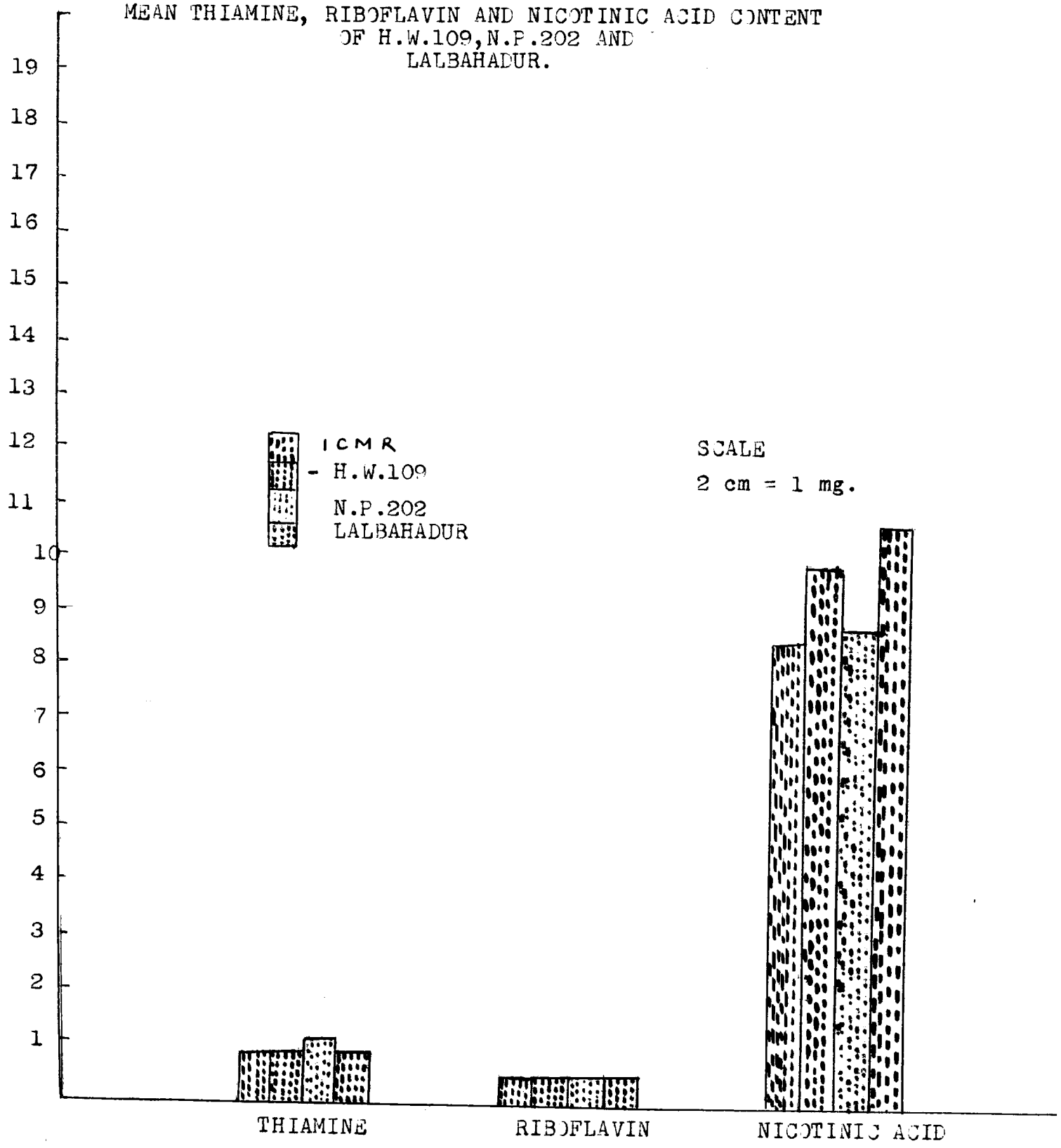
* Significant at 5 per cent level
** Significant at 1 per cent level.

It is interesting to note that the phytate content of N.P.202 has a great advantage in having a lower phytate content than H.W. 109 and Lalbahadur. Since phytates interfere with the absorption and utilisation of calcium and iron it is highly advantageous to have a lower phytate content. However, there are studies which prove that when the diet provides 239 mg. of calcium and 80 mg. phytate the phytate will not influence the absorption of calcium and iron (Robert et al, 1954).

According to the ICMR(1966) the phytate value of the local wheat is 203 mg/100 g flour. Thus there is no significant difference between the phytate content of H.W. 109 and N.P. 202.

F I G U R E -3

MEAN THIAMINE, RIBOFLAVIN AND NICOTINIC ACID CONTENT OF H.W.109, N.P.202 AND LALBAHADUR.



The mean Thiamine content of the three hybrid varieties are given in Table IX. The details of replicate values and the statistical analysis are presented in Appendix XIV. A diagrammatic representation of the thiamine values of the three hybrid varieties are made in Fig. 3.

TABLE IX

MEAN THIAMINE CONTENT OF H.W. 109 N.P. 202 AND LALBAHADUR
(mg/100g flour)

Variety	Thiamine mean ± S.D.	Varieties compared	't'value
H.W. 109	0.543 ± 0.07	H.W. 109 Vs. N.P.202	0.8615
N.P. 202	0.590 ± 0.041	N.P.202 Vs. Lalbahadur	2.057
Lalbahadur	0.518 ± 0.032	Lalbahadur Vs. H.W. 109	0.4892

Statistical analysis shows no significant diggerence among the three varieties. The human requirements of Vit:B_1 is placed at 0.5mg. per 1000 dietary K. calories and in this contex most of the wheat varieties could provide sizable amounts of B_1 vitamin. The thiamine content of ordinary wheat strain as reported by ICMR (1966) is 0.49 mg/100g. of flour. In this basis all the three hybrid varieties have higher thiamine content than the local wheat strain, with N.P. 202 having the highest value.

Table X presents the riboflavin content of H.W. 109, N.P. 202 and Lalbahadur. The statistical appraisal and other details are given in Appendix XV. Fig. 3 represents diagrammatically the riboflavin content of the three hybrids.

TABLE X

MEAN RIBOFLAVIN CONTENT OF H.W. 109, N.P. 202 AND LALBAHADUR (mg/100g flour)

Variety	Riboflavin mean ± S.D.	Varieties compared	't'value
H.W. 109	0.2883 ± 0.0043	H.W.109 Vs. N.P.202	1.70
N.P. 202	0.2607 ± 0.006	N.P.202 Vs. Lalbahadur	1.031
Lalbahadur	0.280 ± 0.006	Lalbahadur Vs. H.W.109	0.4702

The riboflavin content of the three hybrid varieties ranged from 0.2607 to 0.2883 mg. per cent, being similar to each other.

The Table XI presents the mean riboflavin content of H.W. 109, N.P. 202 and Lalbahadur. The details of replicate values and the satistical appraisal are given in Appendix XVI. The values are diagrammatically represented in Fig. 3.

TABLE XI

MEAN NICOTINIC ACID CONTENT OF H.W. 109, N.P. 202 AND LALBAHADUR
(mg/100g flour)

Variety	Nicotinic acid Mean ± S.D.	Varieties compared	't'value
H.W. 109	5.03±0.1	H.W.109Vs.N.P.202	3.018*
N.P. 202	4.36±0.3	N.P.202Vs.Lalbahadur	5.555**
Lalbahadur	5.86±0.3	Lalbahadur Vs. H.W. 109	3.80*

* Significant at 5 per cent level
** Significant at 1 per cent level

The nicotinic acid content of the three varieties ranged from 4.36 to 5.86 mg/100 of flour. The difference between H.W. 109+N.P. 202 was significant at 5 per cent level and the difference between N.P. 202 and Lalbahadur was significant at 1 per cent level, whereas, the difference between Lalbahadur and H.W. 109 was significant at 5 per cent level. N.P. 202 has the lowest value and H.W. 109 has the highest nicotinic acid content among the three varieties.

V. SUMMARY AND CONCLUSION

In concluding the study on "The analysis of three hybrid varieties of wheat for selected nutrients", the question may arise as to which is the best among the three hybrid varieties, H.W. 109, N.P. 202 and Lalbahadur to meet the present and future world needs.

The answer is clear. The need for proteins and calories is so great that all the three varieties can be consumed to the extent practicable. Among the three strains analysed, H.W. 109 has the highest protein content 20.20 g. per cent and a low calcium and phosphorus content; N.P. 202 in addition to a high protein content of 17.26 g/100g has the highest value for thiamine, 0.590mg percent.

Lalbahadur contains the highest calcium (66.87mg percent), phosphorus (290.26 mg per cent) and nicotinic acid (5.86 mg per cent) content and its Ca/P ratio is the optimum 1:4. The ribolfavin content of the three varieties are almost the same. The iron content of all the three varieties is lower than the ICMR value.

Considering all the factors together, it appears that all the three varieties have the most promising nutritional potentialities except for iron and phosphorus.

The hybridisation of wheat thus has bright scope in India. Massive support by the Government to bring larger area under the cultivation of hybrid varieties of wheat would definitely meet the emergency that many foresee in the years immediately ahead.

B I B L I O G R A P H Y

Athwal, D.S. "Recent Developments And Future Possibilities In Food Grain Production In Asia", First Asian Congress of Nutrition Abstracts. Hyderabad: 1971, p. 2.

A.O.A.C. Official Methods of Analysis of The Association Of Official Agricultural Chemists. Washington: 1960, pp. 121 - 124.

Austin, H.D., Singh, Ram, A., Mirchandani. "Quality Characteristics of Improved Wheat Varieties Tried At Different Agroclimatic Conditions In India", Indian Council of Agricultural Research. All India Wheat Research Workers Workshop. New Delhi: 1968, p.1.

Austin, A., Hanslas, V.K., Singh, H.D., Ragaviah, P. "Protein Survey Of Improved Indian Wheat Varieties", Indian Journal Of Agricultural Science. 1970, IV, IV, p. 308.

Bains, G.S., "Effect of Commercial Fertilisers And Green Manure On Yield And Nutritive Value of Wheat With Respect To General Composition, Thiamine, Niacin And The Biological Value Of Protein Grains." Cereal Chemistry. XXX, pp. 139 - 144.

Balasubramanian, S.C., Ramachandran, M. Viswanath, T., "Amino Acid Composition of Indian Food Stuffs", Part 3, Indian Council Of Medical Research. L, 1952, p. 40.

Banerjee, S.K., Swaminathan, M.S . "X Ray Induced Variability For The Protein Content In Bread Wheat". The Indian Journal of Genetics And Plant Breeding. VI, 1966, p. 85.

Beaten, H., George, McHenry Earle Willard. "Calcium And Phosphorus", Nutrition , New York: I, 1964, pp. 261 - 270.

Bhargava, B.S., Motiramani, D.P., "Effect of Fertilisers On The Chemical Composition Of Wheat, At Different Stages Of Growth", Journal of Indian Society Of Soil Science. Bulletin of Grain Technology, 1968, VI, 1, p. 23.

Bhaid, S.V., Srivastava, K.N., Naik, M.S., Das, N.B. "Effect Of Nitrogen Fertilisation On Protein, Lysine And Tryptophan Contents Of Indian And Mexican Wheat Varieties", Proceedings Of The Nutrition Society of India, 7, 1958, pp. 31 - 55.

Directorate Of Economics And Statistics, 1961, Table I, II.

'Deosthale, Y.G., Suryanarayana Rao, K., Mohan, V.S., "Nutritive Value of Wheat Varieties Of India", Journal Of Nutrition And Dietetics. XI, 1969, pp. 182 - 185.

Dixit, R.S., Singh, P.P. "Impact Of High Yielding Varieties On Human Labour Input", Agricultural Situation In India. Directorate of Economics And Statistics, Ministry Of Food And Agriculture, XXIV, XII, 1970, p. 1081.

Felix Browner, Harris S. Robert, Maletskos, J., Constantine, Benda E. Clemns, "Effect Of Food Phytates On Calcium Uptake In Children On Low Calcium Breakfasts", Journal of Nutrition, LIV, 1954, p. 540.

Garg, K.P., Tomaria, P.S. "Note On The Effect Of Nitrogen, Phosphorus, And Potash On Yield And Quality Of Wheat Variety Sonora 64", Indian Journal of Agricultural Economics. XXV, 3, 1970, pp. 120 - 121.

Grain Bulletin; London Common Wealth Secretariat Marlborough House, XVI, IV, 1970, p. 1.

Graham George, G., Robert Placko, P., Acevedo Gladys, Enrique Morales, Angel Corandno. "Lysine Enrichment of Wheat Flour". American Journal Of Clinical Nutrition. XXII, 1969, pp. 1459 - 1469.

Guild Of Service Information Bureque. "A Variety of Wheat Preparations", The Mobile Extension Nutrition Programme. Wheat Associates, Madras: 1963, p. 4.

Health, D.J. "Cereal Products In The Dietary Treatment", Nutrition. XXIII, II, 1969, pp. 91 - 92.

Hutchinson, J.B., Martin, H.F. "Nutritive Value of Bran, Effects Of Fine Grinding Upon Bran And Of Added Bran Upon The Protein Quality Of White Flour", Journal Of Science Of Food And Agriculture. XXI, 1970, pp. 148 - 151.

Indian Council Of Medical Research, Special Report Series, XXIII, 1952.

Indian Council Of Medical Research. "Wheat And Wheat Products As Human Food," Special Report Series, XXIII, 1952, p. 3.

Indira Gandhi. "Broad Cast Of Prime Ministers Message", Kurushetra. XIV, 1966, p. 7.

Iswaran, V., Gour, A.C., Jouhn, K.S. "Coal Increases The Yield Of Paddy And Wheat", Indian Agricultural News Digest, I, VII, 1970, p. 23.

Joint FAO/WHO Expert Committee On Nutrition. Rome: Technical Report Series, XXXVII, 1966, p. 15.

Jones Kent, D.W., Amos, A.G. Modern Cereal Chemistry. The Northern Publishing Company, Liverpool: 1957, p. 58.

Kishen, K., Lakhanpal, R.L. "Statistical Assessment Of High Yielding Varieties Programme In Uttar Pradesh", Agricultural Situation In India. XXIII, X, 1969, pp. 1027 - 1028.

Krishnamurthy, K., "Nutritive Content Of Ragi Varieties In Relation To Fertiliser Levels", Journal Of Nutrition And Dietitics, V., 1968, p. 12.

Kuhn, N.I., Lay Rissie, M., Roche, M. Martinez., , Walker, B.R. "Observation On The Mechanism Of Iron Absorption", The American Journal Of Clinical Nutrition, XXI, 1968, pp. 1184 - 1188.

Lalbahadur Shastri, "Food Self Sufficiency", Kurushetra, XIII, XI, 1965, p. 2.

"Lalbahadur A Break Through In Hybrid Wheat", Financing Agriculture. Agricultural Finance Corporation, 1970, p. 42.

Mattern, P.J., Alisaleem, V.A., Johnson, Schmidt, "Amino Acid Composition Of Selected High Protein Wheats" Cereal Chemistry. LV, 1968, p. 437.

McCance, R.A., Widdowson, E.M., Moren, J., Pingale, W.J.S., MaCrae, T.F. Bio-Chemical Journal, XXIX, 1945, p. 213.

McDermott, E.C., Pace, J. "Comparison Of The Amino Acid Composition Of The Protein In Flour And Endosperm From Different Types Of Wheat", Journal Of Food Science. IX, 1960, p. 194.

Mishra, J.P., Shukla, B.W., "A Study On The Economics Of High Yielding Varieties Programme", Agricultural Situation In India. Directorate Of Economics and Statistics, Ministry Of Food And Agriculture, New Delhi: XXIV, 1969, pp. 107 - 114.

Mohan, V.S., Deosthale, Y.G., "Varietal Difference In Protein Quality Of Cereals And Millets", Proceedings Of The Nutrition Society Of India. Hyderabad: VII, 1969, p. 23.

Nagarajan, V., "Fighting Mal Nutrition", Swasth Hind. XIII, 1968, pp. 131 - 138.

Passmore, R., Sundararajan, A.R. "The Vit. B1 Content Of The Millets Eleucine Coracona And Sorghum Vulgare", Indian Journal Of Medical Research. XXIX, 1941, p. 92.

Pant, K.C., "Grains Of The Green Revolution", Nutrition. Hyderabad: IV, 1970, p. 4.

Pasrichia Swarnan. "Infant Weaning Food", Nutrition. Hyderabad: IV, 1970, p. 14.

Peterson, R.F. "Nutritive Value Of Wheat", Wheat. World Crop Series. Inter Science Publishers Inc., New York: 1965, p. 297.

Ram, K. Vepra. "Increasing Agricultural Productivity", Kurukshetra. XIV, 1962, p. 1.

Ramasastry, B.V., Srinivasa Rao, "Some Studies On The Nutritive Value Of Rice Varieties And Pulses", Proceedings Of The Nutrition Society Of India. VII, 1969, pp. 13 - 14.

Rao, K.K., P.N., "Nutritive Value of Cereals And Other Main Staple Foods"... ~~Nutritive Value of Cereals And Other ain Staple Foods~~", Nutrition News Letter. VII, 1969, pp. 16 - 18.

Ramachandran, K.V. "The World Food Problem", A Special Report To President Johnson. New Delhi: 1967, p. 21.

Rockefeller Foundation Program In The Agricultural Sciences. "Wheat", Progress Report: Toward The Conquest Of Hunger. New York: 1965, 1966, pp. 28, 32. 25.

Sathe, V., Krishnamurthy, K. "Phytic Acid And Absorption Of Iron", Indian Journal Of Medical Research. LI, IV, 1953, pp. 448 - 452.

Shanmuga Sundaram, E.R.B., Sarma, P.S. "Role Of Carbohydrate On The Bio-Synthesis Of Nicotinic Acid In Germinating Green Gram", Journal Of Madras University, XXIV, 1954, pp. 13 - 19.

Swaminathan, M.S., "Genetic Manipulation Of Fertiliser Effectiveness", Fertiliser News. X, 1965, pp. 14 - 15.

Swaminathan, M.S., Khohili, S.P., Anderson, R.G., "Sonora 64, An Early Wheat Dwarf With High Yield", Indian Farming, XVI, 1965, p. 5.

Sukhatme, P.V. "Population And Food Supplies, Present Picture In South East Asia", Proceedings Of The Nutrition Society Of India. I, 1961, p. 1.

Sukhatme, P.V. "The Present Pattern Of Production And Availability Of Foods In Asia", First Asian Congress of Nutrition. 1971, p. 1.

Tara, K.A, Haridas Rao, P., Bains, G.S. "Composition And Baking Quality Of The Product Of Wheat Milling", Journal Of Science, Food And Agriculture. XII, 1969, p. 371.

Uprety, D.C, Austin, "Comparative Study Of The Chemical Composition. Of Baking Quality Of Sonora 64, And Sharbati Sonora", The Indian Journal Of Agricultural Science, XXXIX, 1955, p. 263.

Venkatachalam, P.S., Indian Journal Of Home Science, 1967, I, p. 83.

APPENDICES

APPENDIX I

ESTIMATION OF CALCIUM

Calcium is determined by precipitating it as Calcium Oxalate and titrating the Oxalte solution in dilute sulphuric acid against standard potassium permanganate.

REAGENTS:

1. Ammonium Oxalate (6 per cent) 6 g of Ammonium Oxalate was weighed and dissolved in 100 ml of water.
2. Strong Ammonia
3. Methyl red indicator 0.05 g of methyl red was weighed and dissolved in 100 ml of 50 per cent alcohol.
4. Dilute sulphuric acid (2N) 2 ml of concentrated Sulphuric acid was diluted with 34 ml of water.
5. N $KMnO_4$ solution

   100

Procedure:

25 ml of mineral solution was diluted to about 150 ml with distilled water in a beaker by adding 125 ml of water. A few drops of methyl red were added and the mixture was neutralised with ammonia till the pink colour changed to yellow. The solution was heated to boil and 10 ml of ammonium oxalate was added. The mixture was then allowed to boil for a few minutes and glacial acetic acid was added till the colour was distinctly pink. The mixture was kept aside in a warm

place and when the precipitate settled down, the supernatant was tested with a drop of ammonium oxalate solution to ensure the completion of the precipitation. The precipitate was then filtered through No. 40 whatman filter paper and washed with warm water till free of oxalate; the precipitate was transferred to a beaker by piercing a hole in the filter paper and poured over it, (dilute sulphuric acid about 5 ml;. The solution was then heated to 70°C and titrated against N/100 $KMnO_4$ solution.

Calculations: 1 ml of N/100 $KMNO_4$ = 0.2004 mg of Calcium.

ESTIMATION OF PHOSPHORUS

The determination of phosphorus is carried out by measuring colorimetrically, the blue colour formed when the ash solution is heated with ammonium molybdate, when the phosphomolybdate thus formed is reduced.

Reagents Needed:

1. Ammonium molybdate sulphuric acid reagent:

Dissolved 25 g of ammonium molybdate in 300 ml of water. Diluted 75 ml of $H_2 SO_4$ to 200 ml and added to the ammonium molybdate solution.

2. Hydroquinone Solution:

Dissolved 0.5g of hydroquinone in 100 ml of water and added one drop of $H_2 SO_4$ to retard oxidation.

3. Sodium Sulphite Solution:

Dissolved 200 g of sodium sulphate in water, diluted to 100 ml and filtered.

4. Standard phosphate solution:

Dissolved 0.4394 g of pure dry potassium dihydrogen phosphate in water and diluted to 100 ml to give working standard which contains 0.01 mg/ml of phosphorus.

Procedure:

To an aliquot of 0.1 ml of the mineral solution, 1ml of ammonium molybdate, 1ml of hydroquinone and 1ml of sodium sulphite solution were added, in the same order as given, then the volume was made upto 15 ml with distilled water and the solution was thoroughly mixed. After 30 minutes, the colour developed was measured in a photoelectric colorimeter using a red filter. (650 mμ)

APPENDIX III

Estimation of Thiamine

Reagents required:

1. Acetic Acid 2%

   2 ml of glacial acetic acid in 100 ml of water.

2. 1.5 N Sodium hydroxide:

   6 g of NaoH was dissolved in water and made upto 100 ml of distilled water.

3. 6 per cent Takadiastase (W/v).

   6 g of takadiastase was dissolved in water and made upto 100 ml with distilled water.

4. Methyl Alcohol (distilled)

5. Isobutyl alcohol (distilled)

6. Sodium Hydroxide solution 30%

   30 g of sodium hydroxide was weighed and dissolved and made upto 100 ml with distilled water.

7. Potassium ferricyanide solution (1. per cent).

   1g of potassium ferricyanide was dissolved and made upto 100 ml with distilled water.

8. Thiamine Stock solution:

   125 mg of thiamine hydroxide was dissolved and made upto 100 ml with 2 per cent acetic acid.

9. Working Thiamine standard:

   2 ml of thiamine stock solution was made upto 100 ml with 2 per cent acetic acid.

10. Quinine Sulphate Stock Solution:

100 mg of quinine sulphate dissolved in 0.1N sulphuric acid and made upto 100ml with 0.1N sulphuric acid.

11. Quinine Sulphate Working Standard:

1ml of the intermediate solution was diluted to 100 ml with 0.1N H_2SO_4. This contains 0.05 mg/100ml of this solution.

12. Distilled Alcohol.

Procedure:

Took 5 g of the powdered sample in each of two conical flasks namely A and B. Added 50 ml of acetic acid to each of the flasks. To flask 'B' added 1ml of the standard thiamine solution. Heated the flasks on a water bath for 15 minutes and cooled under running water. Adjusted the p.H. to 4.5 with 1.5 N NaoH (approximately 1.2 ml) till a chocolate brown colour appears with congo red indicator. Added 5 ml of 6 per cent takadiastase solution to each flask and incubated overnight with a tight stopper at 37°C.

Transferred the entire content of each flasks with the rinsings and made upto 100 ml. Filter through whatman No. 40 filter paper, discarding the first few ml.

Took 10 ml of the filtrate in two 50 ml centrifuge tubes and marked them 'A' and 'B'. To the first added 2 ml of methly alcohol, 2 ml of 30 per cent NaoH, and

2 ml of ferricyanide solution in that order. To the other tube added 2 ml of methyl alcohol, 2 ml of 30 per cent NaoH and 2 ml of distilled water instead of ferricyanide. Immediately added 13 ml of Isobutyl alcohol and aerated exactly for 3 minutes with the help of mechanical shaker and centrifuged. Pipetted out the upper Isobutanol layer (10ml) in to a test tube containing 1 ml of ethanol. Protected the tubes from direct light and read the flouescence, setting the fluoremaeter to 100 with quinine sulphate working standard. Treated the blank (a) in the second tube similarly using 2 ml of distilled water in place of ferricyanide solution.

CALCULATION:

Reading of the sample = X

Reading of the sample blank = XO

Reading for the Intermediate standard = Y

Reading for the Intermediate Standard blank = YO

Corrected reading

X - XO = X1

Y - YO = Y1

Reading for the sample = $X_1 - Y_1$

= Z

100 g of the sample contains =

$$\frac{Z \times 2.5 \times 2 \times 100 \times 100 \times 1}{Y1 \quad 5 \quad 10} \text{ kg of thiamine}$$

APPENDIX IV

Procedure:

About 5g of the dry wheat flour was accurately weighed out into a conical flask and 30 ml of 4 N H_2SO_4 was added. The mixture was steamded for 45 minutes. Transferred to a 50 ml flask and volume made up. After making up the solution it was filtered and 25 ml of the filterate was taken in a centrifuge tube and 5 ml of 60 per cent basic lead acetate solution was added. The pH was adjusted to 9.5 using thymol blue till a light blue colour developed. After centrifuging, 2 ml. conc. H_2SO_4 was added to the supernatant and left for an hour. After that any $PbSO_4$ that had precipitated was centrifuged off and 5 ml of 40 per cent H_2SO_4 was added, pH was adjusted to 8.4 with 10 N NaoH, phenolpthalien gives a slight pink colour at the end point. Once again the supernatant after centrifugation was collected and pH adjusted to 7 using bromothymol blue as indicator. The solution should turn just green.

A known amount of the standard nicotinic acid were taken and to that added, 2 ml of cyanogen bromide, 1 ml of aniline and the volume was made upto 10 ml with distilled water.

Reading was taken exactly 10 minutes after the development of colour in a Klett summerson photoelectric colorimeter at 420 mμ.

APPENDIX V

Phytin - Phosphorus Content Of Indian Food Stuffs

Method:

The phytin phosphorus, which is extracted with dilute Hcl, is precipitated as ferric phytate with a known amount of ferric chloride and the excess determined colorimetrically as thiocyanate. The number of milligrams of iron precipitated is equal to the number of milligrams of phytin phosphorus.

Reagents:

1. $\frac{N}{2}$ Hcl and $\frac{N}{6}$ Hcl
2. NaoH solution 40%
3. Standard $Fecl_3$ in Hcl solution.

A solution of A.R. $Fecl_3$ in NHcl is prepared and the iron determined gravimentrially. By suitable dilution with NHcl a solution containing 1.26 mg of iron per c.c. is prepared.

4. 20 per cent KcNS
5. Amyl alcohol.
6. Concentrated iron free HNO_3
7. Standard iron solution 1 c.c. = 0.05 mg Fe.

Procedure:

Samples for estimation were ground to a fine powder in the case of cereals; total phosphorus was estimated

volumetrically, 10 g of test material were shaken in a 250 cc glass stoppered bottle with 100 cc of $\frac{N}{2}$ Hcl for two hours to extract the phytic acid. It was then transferred to a 100 c.c. centrifuge tube and centrifuged for two hours or more to obtain a clear centrifugate. 25 cc of the supernatant were pipetted into a 50 cc measuring flask and neutralised to phenolpthalein with NaOH rendered slightly acid with $\frac{N}{6}$ Hcl and made upto mark with distilled water.

20 cc of the above solution were pipetted into a 35 cc test tube, and 4 cc of the standard $Fecl_3$ - Hcl solution added. The tube was then heated in a rack in a boiling water bath for 15 minutes with the level of the water above that of their contents of the tube. After cooling for 15 minutes in a bath of coldwater the contents of the tube were made upto 50 cc in a measuring flask with distilled water and filtered over a dry filter into a dry flask. Iron was estimated in the filtrate by the thiocyanate amyl alcohol method. The amount of iron necessary for precipitation of phytin is calculated therefrom and this represents the phytin phosphorus.

The results are expressed as mg/100g of the edible portion and on the fresh weight basis.

APPENDIX - VI

STATISTICAL APPRAISAL

't' VALUES FOR MOISTURE CONTENT OF H.W.109 N.P. 202 AND LALBAHADUR.

Variety	Replicate Values g/100		
	1	2	3
H.W. 109	10.52	10.52	10.40
N.P. 202	11.20	11.20	11.08
LALBAHADUR	9.96	9.96	9.86

Test Used:-

$$t = \frac{\bar{x} - \bar{y}}{\sqrt{\frac{Sx^2 + Sy^2}{n - 1}}}$$

H.W.109 Vs-N.P.202.

$$t = \frac{11.16 - 10.48}{\sqrt{\frac{0.0032 + 0.1500}{2}}}$$

t = 2.4575 Not Significant

N.P. 202 Vs. LALBAHADUR

$$t = \frac{11.16 - 9.92}{\sqrt{\frac{0.0032 + 0.14}{2}}}$$

$$= \frac{4.633}{} * *$$

LALBAHADUR VS H.W.109

$$t = \frac{10.48 - 9.92}{\sqrt{\frac{0.032 + 0.14}{2}}}$$

t = 1.9093 Not Significant.

APPENDIX- VII

STATISTICAL APPRAISAL

't' VALUES FOR ASH CONTENT OF H.W.109 N.P.202 AND LALBAHADUR.

Variety	Replicate Values g/100 g.		
	1	2	3
H.W.109	1.43	1.42	1.42
N.P.202	1.62	1.64	1.61
LALBAHADUR	1.84	1.83	1.84

Test Used:

$$t = \frac{\bar{x} - \bar{y}}{\sqrt{\frac{Sx^2 + Sy^2}{n - 1}}}$$

H.W.109 Vs.N.P.202

$$= \frac{1.623 - 1.423}{\sqrt{\frac{p.0.0124 + 0.668}{2}}}$$

$$t = \frac{0.03430}{}$$

N.P.202 Vs Lalbahadur

$$t = \frac{1.84 - 1.62}{\sqrt{\frac{0.668}{2}}}$$

$$t = 0.01170$$

APPENDIX - VIII

STATISTICAL APPRAISALS

't' VALUES FOR PROTEIN CONTENT OF H.W.109. N.P.202 AND LALBAHADUR.

Variety	Replicates Values g/100 g.		
	1	2	3
H.W.109	20.4	20.3	20.3
N.P.202	17.5	17.5	16.8
LALBAHADUR	14.0	13.7	13.7

Test Used:

$$t = \frac{\bar{x} - \bar{y}}{\sqrt{\frac{Sx^2 + Sy^2}{n - 1}}}$$

H.W.109 Vs N.P.202

$$t = \frac{20.16 - 17.26}{\sqrt{\frac{0.43 + 0.23}{2}}}$$

$$t = 4.699 * *$$

N.P.202 Vs LALBAHADUR

$$t = \frac{17.26 - 13.7}{\sqrt{\frac{1.86 + 0.23}{2}}}$$

$$t = 3.4833 *$$

LALBAHADUR Vs H.W.109

$$= \frac{20.16 - 13.7}{\sqrt{\frac{1.86 + 0.43}{2}}}$$

$$= 6.037 * *$$

APPENDIX - IX

STATISTICAL APPRAISAL

't' VALUES FOR CALCIUM CONTENT OF H.W.109, N.P.202 AND LALBAHADUR.

Variety	Replicate Values mg/100 g.		
	1	2	3
H.W.109	46.49	47.42	46.82
N.P.202	52.56	52.54	52.54
LALBAHADUR	65.56	69.44	65.63

Test Used:

$$t = \frac{\bar{x} - \bar{y}}{\sqrt{\frac{Sx^2 + Sy^2}{n - 1}}}$$

H.W.109 Vs N.P.202

$$t = \frac{52.54 - 46.91}{\sqrt{\frac{0.4455 + 0.7006}{2}}}$$

$$t = 23.52 **$$

N.P.202 Vs LALBAHADUR

$$t = \frac{66.87 - 52.54}{\sqrt{\frac{2.3778 + 0.7006}{2}}}$$

$$t = 11.584 * *$$

LALBAHADUR Vs H.W.109

$$t = \frac{66.87 - 46.91}{\sqrt{\frac{2.3778 + 0.4455}{2}}}$$

$$t = 16.80 * *$$

APPENDIX- X

STATISTICAL APPRAISAL

't' VALUES FOR IRON CONTENT OF H.[illegible].109, N.P.202 AND LALBAHADUR.

Variety	Replicates Values mg/100 g. 1	2	3
H.W.109	2.033	2.032	2.032
N.P.202	2.062	2.063	2.063
LALBAHADUR	1.770	1.770	1.790

Test Used:

$$t = \frac{\bar{X} - \bar{Y}}{\sqrt{\frac{\Sigma X^2 + \Sigma Y^2}{n - 1}}}$$

H.W.109 Vs N.P.202

$$t = \frac{2.032 - 2.062}{\sqrt{\frac{0.0004 + 0.0005}{2}}}$$

$$t = 0.2342 \text{ Not Significant}$$

N.P.202 Vs LALBAHADUR

$$t = \frac{2.062 - 1.780}{\sqrt{\frac{0.00094 + 0.0119}{2}}}$$

$$t = 2.702 \text{ Not Significant}$$

LALBAHADUR Vs H.W.109

$$t = \frac{2.032 - 1.780}{\sqrt{\frac{0.0005 + 0.0119}{2}}}$$

$$t = 3.837 *$$

APPENDIX - XI

STATISTICAL APPRAISAL

't' VALUES FOR PHOSPHORUS CONTENT OF H.W.109, N.P. 202 AND LALBAHADUR.

Variety	Replicates Values mg/100 g.		
	1	2	3
H.W.109	220.82	220.84	220.83
N.P.202	280.00	279.90	279.90
LALBAHADUR	290.24	290.30	290.26

Test Used:

$$t = \frac{\bar{x} - \bar{y}}{\sqrt{\frac{Sx^2 + Sy^2}{n - 1}}}$$

H.W.109 Vs N.P.202

$$t = \frac{279.90 - 220.80}{\sqrt{\frac{18.6}{2}}}$$

$$t = 19.43 \ * \ *$$

N.P.202 Vs LALBAHADUR

$$t = \frac{290.2 - 279.9}{\sqrt{\frac{18.66}{2}}}$$

$$t = 3.306 \ *$$

LALBAHADUR Vs H.W.109

$$t = \frac{290.26 - 220.83}{\sqrt{\frac{0.1553 + 0.5374}{2}}}$$

$$t = 118.48 \ **$$

APPENDIX- XII

STATISTICAL APPRAISAL

VALUES FOR PHYTATE CONTENT OF H.W.109, N.P.202 AND LALBAHADUR.

Variety	Replicate Values mg/100 g.		
	1	2	3
H.W.109	208.53	208.54	208.54
N.P.202	166.66	166.67	166.66
LALBAHADUR	208.33	208.34	208.34

Test Used:

$$t = \frac{\bar{x} - \bar{y}}{\sqrt{\frac{S_x^2 + S_y^2}{n - 1}}}$$

H.W.109 Vs N.P.202

$$= \frac{208.54 - 166.66}{\sqrt{\frac{4.1707 + 2.7804}{2}}}$$

$$t = 17.35$$

N.P.202 Vs Lalbahadur

$$t = \frac{208.34 - 166.66}{\sqrt{\frac{2.7804 + 1.003}{2}}}$$

$$t = 17.25$$

LALBAHADUR Vs H.W 109

$$t = \frac{208.53 - 208.33}{\sqrt{\frac{4.1707 + 1.003}{2}}}$$

$$t = \frac{1.9009}{}$$

APPENDIX XIII

STATISTICAL APPRAISAL

't' VALUES FOR THIAMINE CONTENT OF H.W.109, N.P.202 AND LALBAHADUR.

Variety	Replicates Values mg/100 g.		
	1	2	3
H.W.109	0.542	0.544	0.545
N.P.202	0.610	0.582	0.582
LALBAHADUR	0.510	0.524	0.518

Test Used:

$$t = \frac{\bar{x} - \bar{y}}{\sqrt{\frac{Sx^2 + Sy^2}{2}}}$$

H.W.109 Vs N.P.202

$$t = \frac{0.590 - 0.543}{\sqrt{\frac{0.00420 + 0.00175}{2}}}$$

$t = 0.8615$ Not Significant

N.P.202 Vs LALBAHADUR

$$t = \frac{0.590 - 0.518}{\sqrt{\frac{001749 + 0.000729}{2}}}$$

$t = 2.057$ Not Significat

LALBAHADUR Vs H.W.109

$$t = \frac{0.543 - 0.518}{\sqrt{\frac{.005221}{2}}}$$

$t = 0.4892$ Not Significant.

APPENDIX - XIV

STATISTICAL APPRAISAL

't' VALUES FOR RIBOFLAVIN CONTENT OF H.W.109, N.P.202 and LALBAHADUR.

Variety	Replicate Values mg/100 g.		
	1	2	3
H.W.109	0.2882	0.2883	0.2883
N.P.202	0.2607	0.2603	0.2604
LALBAHADUR	0.2803	0.2804	0.2804

Test Used:

$$t = \frac{\bar{x} - \bar{y}}{\sqrt{\frac{S_x^2 + S_y^2}{2}}}$$

H.W.109.Vs N.P.202

$$t = \frac{0.2883 - 0.2604}{\sqrt{\frac{0.0003475 + 0.0001922}{2}}}$$

t = 1.7 Not Significant

N.P.202 Vs LALBAHADUR

$$t = \frac{0.2803 - 0.2604}{\sqrt{\frac{0.0003475 + 0.0003938}{2}}}$$

t = 1.031 Not Significant

LALBAHADUR Vs H.W.109

$$t = \frac{0.2883 - 0.2804}{\sqrt{\frac{0.0001922 + 0.0003738}{2}}}$$

t = 0.4702 Not Significant.

APPENDIX - XV

STATISTICAL APPRAISALS

't' VALUES FOR NICOTINIC ACID CONTENT OF H.W.109, N.P.202 AND LALBAHADUR.

Variety	Replicates Values mg/100 g.		
	1	2	3
H.W.109	5.03	5.03	5.04
N.P.202	4.41	4.41	4.25
LALBAHADUR	5.80	5.80	6.00

Test Used:

$$t = \frac{\bar{x} - \bar{y}}{\sqrt{\frac{Sx^2 + Sy^2}{n - 1}}}$$

H.W.109 Vs N.P.202

$$t = \frac{5.03 - 4.36}{\sqrt{\frac{0.065 + 0.0335}{2}}}$$

$$t = 3.018 *$$

N.P.202 Vs LALBAHADUR

$$t = \frac{5.86 - 4.36}{\sqrt{\frac{0.0804 + 0.0651}{2}}}$$

$$t = 5.55 * *$$

LALBAHADUR Vs H.W.109

$$t = \frac{5.03 - 5.86}{\sqrt{\frac{0.0335 + 0.0804}{2}}}$$

$$t = 3.80 *$$

APPENDIX - XIV

STATISTICAL APPRAISAL

't' VALUES FOR RIBOFLAVIN CONTENT OF H.W.109, N.P.202 AND LALBAHADUR.

Variety	Replicate Values mg/100 g.		
	1	2	3
H.W.109	0.2884	0.2883	0.2883
N.P.202	0.2607	0.2603	0.2604
LALBAHADUR	0.2803	0.2804	0.2804

Test Used:

$$t = \frac{\bar{x} - \bar{y}}{\sqrt{\frac{Sx^2 + Sy^2}{n - 1}}}$$

H.W.109.Vs N.P.202

$$t = \frac{0.2883 - 0.2604}{\sqrt{\frac{0.0003475 + 0.0001922}{2}}}$$

t = 1.7 Not Significant

N.P.202 Vs LALBAHADUR

$$t = \frac{0.2803 - 0.2604}{\sqrt{\frac{0.0003475 + 0.0003938}{2}}}$$

t = 1.031 Not Significant

LALBAHADUR Vs H.W.109

$$t = \frac{0.2883 - 0.2804}{\sqrt{\frac{0.0001922 + 0.0003738}{2}}}$$

t = 0.4702 Not Significant.