

**IN THE NAME OF ALLAH,
THE COMPASSIONATE,
THE MERCIFUL.**

وَأَنْزَلْنَا الْحَدِيدَ فِيهِ بَأْسٌ شَدِيدٌ وَمَنَافِعُ لِلنَّاسِ

اور آمارا ہم نے لوہا جس میں بڑی طاقت ہے اور لوگوں کے لیے فوائد ہیں —

(نوع ۱۸ - سورۃ الحديد پارہ ۲۷)

BIO-EVALUATION OF LYSINE IMPROVED BARLEY PROTEINS

BY
FAQIR MUHAMMAD ANJUM
M.Sc. (UAF)

Thesis submitted in partial fulfilment of the
requirements for the degree of

Doctor of Philosophy

IN

FOOD TECHNOLOGY


FACULTY OF AGRICULTURAL ENGINEERING AND TECHNOLOGY

UNIVERSITY OF AGRICULTURE

FAISALABAD


1988

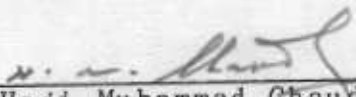
To

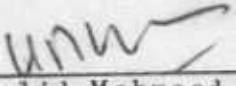

The Controller of Examinations.

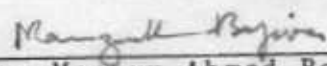
The members of the Committee find the thesis submitted by Mr. Faqir Muhammad Anjum satisfactory and recommend that it be processed for evaluation by external examiner(s) for the award of degree.



CHAIRMAN : 
(Dr. Amjad Ali)

MEMBER : 
(Dr. Haji Muhammad Chaudhry)

MEMBER : 
(Dr. Khalid Mahmood Khan)

MEMBER : 
(Dr. Manzur Ahmed Bajwa)

Love To PAKISTAN N N N

ACKNOWLEDGEMENTS

The auther finds no words at his command to express his deepest sense of gratitude to Almighty Allah (The kind and Merciful), who enabled him to complete this piece of research work.

The auther wishes to extend his sincere thanks to Dr. Amjad Ali, Chairman and Associate professor of Food Technology for his great help, inspiring guidance, consistent encouragement given in planning, execution and final presentation of this manuscript; to Dr. Haji Muhammad Chaudhry, Professor of Food Technology, for his constructive criticism and valuable suggestions and to Dr. Khalid Mahmood Khan, Associate Professor of Bio-chemistry for his critical review of the manuscript.

I am under immense gratitude to Dr. Manzur Ahmed Bajwa, Director General Agriculture (Research), Ayub Agricultural Research Institute, Faisalabad who inspite of his multifarious engagements provided kind help, illuminating guidance and valuable suggestions without whose continued support, the present work would not have been possible.

I wish to bring my sincere thanks to my senior colleagues; Mr. Manzoor Ullah, Cereal Technologist; Mr. Niaz Muhammad, Soil Fertility Officer, Mr. A.G. Khan, Cytogenticist, Hayat Muhammad Bhatti, (Retd.) Agricultural Chemist (Soil) and Dr. N.I. Khan, Botanist (Bio-tech.), Ayub

Agricultural Research Institute, Faisalabad for providing required materials and other facilities during research and also critically reviewing my work.

Deep appreciation is also due to Dr. Muhammad Hussain Chaudhry, Director, Wheat Research Institute, Faisalbad and Dr. M. Akmal Khan, CSO, National Agricultural Research Centre, Islamabad for providing facilities during the conduct of this study.

Last but not least I am obliged to all my friends, especially Mr. Kausar Nawaz Shah and Muhammad Javed for their sympathetic attitude and co-operation to finalize this manuscript.

[Handwritten Signature]
Faculty of Agr. Engrg. & Technol.
University of Agriculture
FAISALABAD.

[Handwritten Signature]
CHAIRMAN,
Dept. of Food Technology
University of Agriculture,
FAISALABAD.

CHAPTER CONTENTS

| <u>CHAPTER</u> | | <u>PAGE</u> |
|----------------|------------------------------|-------------|
| I | INTRODUCTION | 1 |
| II | REVIEW OF LITERATURE | 6 |
| III | MATERIALS AND METHODS | 44 |
| IV | RESULTS AND DISCUSSION | 59 |
| V | SUMMARY | 149 |
| VI | LITERATURE CITED | 156 |
| | APPENDICES | 175 |

[Handwritten mark]

LIST OF TABLES

| No. | Title | Page |
|-----|--|------|
| 1. | Detail of the material studied in the segregating generations (F2-F5). | 45 |
| 2. | Description of promising barley lines tested in regular barley (B) trial during 1982-83. | 48 |
| 3. | Composition of Neutripol; vitamin-mineral premix. | 53 |
| 4. | Composition of different experimental diets. | 54 |
| 5. | Mean, range, coefficient of variability and standard deviation in F2 barley plants. | 60 |
| 6. | Simple correlation coefficients between 100 kernel weight, protein and DBC value in F2 plants. | 66 |
| 7. | Mean, range, coefficient of variability and standard deviation in F3 barley plants. | 68 |
| 8. | Simple correlation coefficients between 100 kernel weight, protein and DBC value in F3 plants. | 74 |
| 9. | Mean, range, coefficient of variability and standard deviation in F4 barley plants. | 77 |
| 10. | Simple correlation coefficients between 100 kernel weight, protein and DBC value in F4 plants. | 82 |
| 11. | Yield and other characteristics of promising barley lines tested in A trial during 1981-82. | 87 |
| 12. | 100 kernel weight, protein and DBC value of promising barley lines tested in A trial during 1981-82. | 90 |
| 13. | Correlation of yield and other quality parameters in barley lines tested in preliminary yield trial. | 94 |
| 14. | Components of yield and other important traits recorded on barley lines in B trial. | 96 |

| | | |
|-----|---|-----|
| 15. | Analysis of variance for yield, components of yield and other traits recorded on barley lines in B trial. | 97 |
| 16. | Days to heading and maturity of different barley lines in B trial. | 100 |
| 17. | Analysis of variance for days to heading and maturity in B trial. | 101 |
| 18. | Proximate composition of promising barley lines in B trial. | 104 |
| 19. | Analysis of variance for proximate composition. | 105 |
| 20. | Protein fractions of different barley lines in B trial. | 109 |
| 21. | Analysis of variance for different protein fractions. | 110 |
| 22. | Amino acid spectrum of different barley lines in B trial. | 114 |
| 23. | Fatty acid composition of different barley lines in B trial. | 117 |
| 24. | Mineral composition of different barley lines in B trial. | 121 |
| 25. | Analysis of variance of mineral composition of barley lines in B trial. | 122 |
| 26. | Phytic acid and tannins of different barley lines in B trial. | 125 |
| 27. | Biological evaluation of different barley lines in B trial. | 127 |
| 28. | Analysis of variance for biological evaluation traits. | 128 |
| 29. | Simple correlation coefficients between yield and other quality traits in barley B trial. | 133 |
| 30. | Farinograms interpretations of different barley blended wheat flour. | 136 |
| 31. | Effect of barley blended wheat flour on the quality of bread. | 140 |

- | | | |
|-----|---|-----|
| 32. | Effect of barley blended wheat flour on the quality of chapati. | 143 |
| 33. | Mean, range, heritability (Broad sense) and genotypic coefficient of variability for seven characters. | 145 |
| 34. | Phenotypic (P), genotypic (G) and environmental(E) correlation among different traits of barley (<i>Hordeum vulgare</i>). | 147 |
| 35. | Direct effect (in paranthesis) and indirect effect matrix. | 148 |

LIST OF FIGURES.

| <u>No.</u> | <u>Title</u> | <u>Page</u> |
|------------|---|-------------|
| 1. | Trend in area, production and yield of barley in pakistan. | 4 |
| 2. | Relationship of 100 kernel weight with protein content in F2 plants. | 63 |
| 3. | Relationship of 100 kernel weight with DBC value in F2 plants. | 64 |
| 4. | Relationship of protein content with DBC value in barley F2 plants. | 65 |
| 5. | Relationship of 100 kernel weight with protein content in barley F3 plants. | 71 |
| 6. | Relationship of 100 kernel weight with DBC value in barley F3 plants. | 72 |
| 7. | Relationship of protein with DBC value in F3 plants. | 73 |
| 8. | Relationship of 100 kernel weight with protein content in F4 plants. | 79 |
| 9. | Relationship of 100 kernel weight with DBC value in F4 plants. | 80 |
| 10. | Relationship of protein content and DBC value in F4 plants. | 81 |
| 11. | Farinograms of various levels of barley supplemented flour in wheat Pak 81. | 138 |

LIST OF APPENDICES

| <u>No.</u> | <u>Title</u> | <u>Page</u> |
|------------|---|-------------|
| 1. | Quality evaluation of F2 generation of barley during 1977-78. | 175 |
| 2. | Quality evaluation of F3 generation during 1978-79. | 179 |
| 3. | Quality evaluation of F4 generation during 1979-80. | 181 |
| 4. | Quality evaluation of F5 generation during 1980-81. | 187 |



INTRODUCTION

CHAPTER I

INTRODUCTION

Significant nutritional role played by cereals had long been recognised in excavation of agricultural sites dating around 8000 BC (Harlan, 1971). Barley after wheat, rice and corn, ranks fourth in both growing area and production amongst the cereal crops in the world. During the year 1983, area, production and yield of barley in the world were 79.77 million hectares (mha), 169.4 million tonnes (mt) and 2123 Kg/ha, respectively (Mekni and Kourieh, 1984). The area under barley increased significantly during the last two decades due to its relatively better tolerance to salinity and drought conditions, good performance on marginal low fertility soils as well as its high biological value. Suffice to say that barley possesses inherent capability to grow well under stress conditions of salinity and moisture where other cereal crops almost fail to thrive or survive.

In many countries; especially developing the main issues in human nutrition today are the general shortage of calories, protein and deficiency in essential amino acids. This has attracted the attention of scientists working in different countries. In human race, the most vulnerable groups are the growing children and pregnant/lactating women. Like other countries, eight percent of pre-school children in rural areas of Pakistan suffer from malnutrition and dwarfism. According to the World Health Organisation,

the protein energy malnutrition (PEM) affects 500 million people, out of which 10 million children die every year due to this malnutrition (Khan and Rana, 1986).

Plant sources; especially cereals, supply two third (68.5%) of the total protein intake for majority of the world's population. The cereal protein quality is considered a second rate protein mainly because of the low content of essential amino acids i.e. lysine, threonine and methionine (lysine being the first limiting amino acid). Besides, the protein carbohydrate ratio in cereals varies from 1:8 to 1:10 which is quite low as compared to that in other foods. Therefore, quantitative and qualitative improvement in cereal protein offers an effective solution of the nutritional problem by providing better diet to the masses through plant sources of protein (Sigurbjornsson, 1970).

As far as nutritional quality is concerned the discovery of Opaque-2 and Floury-2 mutants in maize (Mertz et al., 1964 and Nelson et al., 1965) with higher lysine content in seed motivated the plant breeders to search for varieties with improved protein quality in other cereals as well. In short span of time, not only a high protein and high lysine barley variety Hiproly was identified from the world barley collection (Munck et al., 1970) but a high lysine and low protein Riso Mutant 1508 (Ingversen et al., 1973a) was developed. This was followed by the discovery of a high lysine sorghum variety (Singh and Axtell, 1973).

In Pakistan barley is used both as human food and animal feed while small quantities are also utilized for the preparation of malt for infant's food as well as for soft drinks. As human food, barley is consumed as pearl barley, flour for unleavened bread, and ground grain for porridge. It is also locally used as "Sattoo". Since the limiting factors in barley are lysine and threonine (Howe et al., 1965 and Khan, 1981) which, if improved genetically, would quantitatively substantiate the available protein and thus improve the dietary status of the masses, especially in rainfed areas of Pakistan, where the barley can perform excellently.

The area under barley in Pakistan ranged from 0.415 to 0.580 mha with 0.111 to 0.164 mt of grain production resulting an average yield of 673 to 697 kg/ha from 1947-48 through 1985-86, respectively. The trend in area, production and yield of barley shown in Fig. 1 indicates a static trend since independence, which shows its decades-long neglect. However, the improvement work on barley has been started recently which resulted in releasing a new barley variety 'Jau' 83 by Wheat Research Institute, Faisalabad.

Keeping in view the genetic improvement in nutritional quality of barley, the present studies were undertaken to delineate the high yielding lines of barley possessing higher levels of lysine. To achieve the set goals, following series of experiments to test subsequent