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# Quality Evaluation of Wheat-Mungbean Flour Blends and Their Utilization in Baked Products

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**Abstract:** The prevalence of protein energy malnutrition is increasing in developing economies especially in Pakistan owing to poverty and consumer's reliance on plant sources to meet their energy requirements. The food diversification is one tool to eliminate the protein energy malnutrition and pulses holds potential for their utilization in cereal-based products to improve the protein quality. The core objective of present research investigation is devising strategy to curtail protein malnutrition through composite flour technology. For the purpose, wheat variety (Inqulab-91) and mungbean variety (NM-2006) were used for preparation of flour blends that were further evaluated for their quality and their potential application in baked products. The results regarding the farinographic characteristics indicated that water absorption capacity (60.8%) and mixing tolerance index (120 BU) were higher in 15% and 25% mungbean flour blend, respectively. Moreover, mungbean addition improved some chemical attributes e.g. protein from 5.40-9.30%) fat from 21.3-23.7% and fiber from 0.40-0.95%. Similarly, calorific value also increased from 485-501.1 kcal/100 g. Results pertaining to mineral profile portrayed the increasing tendency for sodium, potassium, iron, magnesium, zinc and manganese with gradual increase in mungbean flour. Sensory characteristics of the product were also improved significantly. In the nutshell, mungbean is an ideal candidate for improving the protein contents of cereal-based products.

**Key words:** Cereals, mungbean, supplementation, malnutrition, protein

## INTRODUCTION

Legumes are vital source of dietary protein for large sector of the world's population. The consumption is predominant in countries where utilization of animal protein is limited owing to poverty, non-availability, religious or cultural lifestyles (Boye *et al*., 2010). Legumes are high in protein and complex hydrocarbons along with presence of appreciable quantities of bioactive ingredients and minerals (Bazzano *et al*., 2001; Villegas *et al*., 2008; Rizkalla *et al*., 2002; Anderson and Major, 2002; Bazzano *et al*., 2008). Moreover, legumes possess some phytochemicals of interests including antioxidants, phytosterols and bioactive carbohydrates (Amarowicz and Pegg, 2008; Rochfort and Panozzo, 2007).

Cereals are staple foods for human nutrition and their incorporation into various products is of great economic importance (Pena *et al*., 2006). Among cereals, most of the inhabitants use wheat (*Triticum aestivum* L.) as an ample food due to the scrupulous properties of proteins in flour which accelerate rheological properties of dough related to baking quality (Svec and Hruskova, 2010). However, wheat hold lower amount of protein and also deficient in certain amino acids cause the dilemma of malnutrition. World protein requirements persist to be a worldwide matter with heightened concerns about food security and protein malnutrition (De-Frias *et al*., 2010). It is a major bottleneck in developing and under-developed countries including Pakistan. Due to insufficient supply of food proteins, legumes use as nutritional supplements in wheat flour to minimize protein malnutrition (Ofuya and Akhidue, 2005).

From the nutritional point of view, legumes are of particular interest for the reason that they contain high amounts of protein (18-32%). In addition to providing a source of essential amino acids and bioactive peptides, pulse proteins possess functional properties such as fat binding, water holding, foaming and gelation that boost up their potential use in wide variety of food products (Boye *et al*., 2010). For these reasons, legumes are ideal supplement to cereals in vegetarian diets with increased attention and concentration as functional ingredient. (Shahzadi *et al*., 2005) concluded that blending various legumes with wheat flour, improves rheological and sensoric characteristics of chapatti. Amongst legumes, mungbean (*Vigna radiata* L. Wilczek) is an excellent source of high quality protein and is one of the cheapest and richest sources of plant protein

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(Akaerue and Onwuka, 2010). Moreover, mungbean is rich in essential fatty acids, antioxidants and minerals (Kollarova *et al*., 2010). Therefore, mungbean-wheat flour blends can be used as alternate or in combination with other ingredients in many food products (Kenawi *et al*., 2009). Consumption of mungbean supplemented products can fulfill requirements of essential amino acids (Iqbal *et al*., 2006). Thus keeping above all facts, following study has been designed to prepare the wheat-mungbean flour blends. The quality estimation and their potential application in cereal-based products are the limelight the manuscript. The outcomes of present research are important for all stakeholders to devise strategy to culminate the menace of protein energy malnutrition through blending of wheat-mungbean flour.

## MATERIALS AND METHODS

Wheat variety Inqulab-91 and mungbean variety NM-2006 used in this study were procured from Ayub Agriculture Research Institute (AARI, Faisalabad). Moreover, chemicals were procured from Sigma-Eldritch and Fluka, whilst ingredients of products were purchased from local market.

**Chemical analysis of wheat and mungbean flour:** Moisture content was determined according to the procedure described in AACC (2000) method No. 44-15A. The nitrogen content in flour samples was determined by Kjeldahl's method as described in AACC (2000) method No. 32-10. The protein was calculated by multiplying nitrogen percentage with a factor 6.25. Crude fat was determined from each sample by using Soxhelt apparatus (AACC, 2000) using method No. 30-25. Crude fiber was determined from previous fat extracted sample by following the procedure mentioned in AACC (2000) method No. 32-10. Ash content was determined by AACC (2000) method No. 08-01.

**Preparation of wheat-mungbean flour blends:** Wheat-mungbean flour blends were prepared by gradual replacement of straight grade flour. For the purpose, following levels of supplementations were used like 0, 5, 10, 15, 20, 25% mungbean flour (Table 1).

Table 1: The formulation of wheat-mungbean flour blends

| Treatments | Straight grade flour (%) | Mungbean flour (%) |
|---|---|---|
| $T_0$ | 100 | 0 |
| $T_1$ | 95 | 5 |
| $T_2$ | 90 | 10 |
| $T_3$ | 85 | 15 |
| $T_4$ | 80 | 20 |
| $T_5$ | 75 | 25 |

**Chemical analysis of wheat and mungbean flour:** The chemical attributes of flour blends will be measured as described in the earlier section using the protocols described in AACC (2000).

**Farinographic studies of composite flour:** Rheological attributes of flour blends were studied using farinogrpah. Farinographic characteristics were determined that include water absorption capacity, Dough Development Time (DDT), Dough Stability (DS), Mixing Tolerance Index (MTI) and dough softening. Brabender Farinograph (C.W. Braber Co. 50 F. Wesley St. S. Hackensack) was used for rheological properties according to AACC (2000) method No. 54-21.

**Preparation of cookies:** The cookies were prepared from all treatments made by following the procedure described in AACC (2000) method No. 10-50D.

**Physical and chemical attributes of cookies:** The width, thickness, weight and spread factor for cookies was determined according to the method described in AACC (2000). Width (cm) of six cookies was determined by placing the cookies next to each other horizontally and the total diameter was measured. The thickness (mm) was measured by placing six cookies on one another and the total height was measured. The tests were repeated thrice to bring meticulousness. The spread factor was calculated according to the formula i.e. $SF = W/T \times 10$. The moisture content, total ash, crude protein, crude fat and crude fiber were also analyzed as described in chemical analysis of wheat flour following the method given in AACC (2000).

**Mineral analysis of cookies:** Mineral analysis of cookies was done by the procedure described in AOAC (2003) method No. 3.014-016. The mineral content i.e. Na, K, Fe, Mg, Ca, Zn and Mn were estimated by using Atomic Absorption Spectrophotometer (A Analyst 100, Perkin Elmer, Norvalk, C.T., USA) in acetylene air flame at wavelengths: 422 nm, 248 nm, 325 nm, 214 nm and 279.5 nm, respectively.

**Calorific value:** Calorific value was calculated through Oxygen Bomb Calorimeter (AACC, 2000).

**Sensory evaluation of cookies:** Sensory evaluations of cookies were carried out using 9-point hedonic scale. The trained taste panel was asked to rate the cookies for their various sensory attributes like color, taste, crispness and surface characteristics as described by (Larmond, 1977).

**Statistical analysis:** The values present in Tables are means of three replications. The Analysis of Variance (ANOVA) was applied to determine the level of significance. The significant differences among means were further compared through Duncon Multiple Range test (DMRt) according to the procedure outline by (Steel *et al*., 1997).

## RESULTS AND DISCUSSION

**Chemical analysis of wheat and mungbean flour:** Straight grade flour of wheat variety Inqulab 91 was checked for proximate composition and the results showed that wheat flour is deficient in protein (12.45%), ash (0.281%) and crude fiber content (1.25%) compared to legumes. Mungbean variety NM-2006 is rich in protein (26.25%), ash (2.97%) and fiber content (3.90%) compared with wheat. The results are in close agreement with the findings of Dzudie and Hardy, 1996; Butt *et al.*, 2001; Randhawa *et al.*, 2002, who found the protein content, fat content and ash content of mungbean as 24.9%, 0.9% and 2.8% respectively.

**Farinographic studies of composite flour:** Farinographic studies provide information about the water absorption, Dough Development Time (DDT), Dough Stability (DS), Mixing Tolerance Index (MTI) and dough softening. It is clear from the results that water absorption was significantly affected by the addition of mungbean flour. The highest water absorption value was observed in $T_3$ (60.8) while water absorption capacity of wheat flour was the lowest (58.4). DDT was not significantly affected by the addition of mungbean flour. These findings are in close agreement with the findings of Harinder *et al.*, 1999. The highest Mixing Tolerance Index (MTI) was observed in $T_5$ (120) while mixing tolerance index of $T_1$ was the lowest (20). The results showed that dough stability was significantly affected by the addition of mungbean flour. The highest dough stability was observed in $T_1$ (17.5) while dough stability of $T_4$ and $T_5$ was the lowest (2.5). It was concluded from the results that degree of softening was significantly affected by the addition of mungbean flour. Degree of softening of different treatments among which the highest degree of softening was observed in $T_5$ (150) while degree of softening of $T_1$ was the lowest (50) as given in Table 3.

**Physico-chemical analysis of cookies supplemented with mungbean flour:** It was evident from the results that diameter was significantly affected by the addition of mungbean flour. Diameter of different treatments among which, the highest diameter was observed in $T_4$ (26.55) and the lowest $T_1$ (24.70). It was clear from the results that thickness was significantly affected by the addition of mungbean flour. The highest thickness was observed in $T_4$ (6.00) while thickness of cookies of treatment $T_1$ was the lowest (5.65) as shown in Table 4. Similar were the findings of Hussain *et al.*, 2006. Spread factor was significantly affected by the addition of mungbean flour. The spread factor of different treatments among which the highest thickness was observed in $T_3$ (44.69) while spread factor of cookies of treatment $T_0$ was the lowest (42.99). It was evident from the results that weight was not significantly affected by the addition of mungbean flour. The highest weight was observed in $T_0$ (8.80) while weight of cookies of treatment $T_2$ was the lowest (7.17). Cookies were also analyzed for their proximate analysis. The results showed that moisture (1.45-1.90%), ash (0.65-1.45%), protein (5.40-9.30%), fat (21.3-23.7%) and fiber content (0.40-0.95%) was significantly affected by the addition of mungbean flour.

Table 2: Chemical composition (%) of straight grade flour wheat and mungbean variety

| Variety | Moisture | Protein | Ash | Crude fat | Crude fiber |
|---|---|---|---|---|---|
| Inqulab 91 | 10.23 | 12.45 | 0.281 | 2.96 | 1.25 |
| NM-2006 | 2.45 | 26.25 | 2.970 | 1.12 | 3.90 |

Table 3: Farinographic characteristics of different composite flour

| Treatments | WA (%) | DDT (min) | MTI (BU) | DS (min) | DOS (BU) |
|---|---|---|---|---|---|
| $T_0$ | 58.4$^a$ | 4.0$^a$ | 50$^d$ | 9.0$^b$ | 95$^c$ |
| $T_1$ | 59.5$^c$ | 3.5$^a$ | 20$^e$ | 17.5$^a$ | 50$^e$ |
| $T_2$ | 60.0$^b$ | 3.0$^a$ | 80$^c$ | 5.0$^c$ | 80$^d$ |
| $T_3$ | 60.8$^a$ | 3.5$^a$ | 60$^d$ | 6.0$^c$ | 100$^c$ |
| $T_4$ | 60.5$^{ab}$ | 3.5$^a$ | 100$^b$ | 2.5$^d$ | 130$^b$ |
| $T_5$ | 60.3$^b$ | 4.0$^a$ | 120$^a$ | 2.5$^d$ | 150$^a$ |

WA = Water Absorption %, DOS = Degree of Softening (BU)

**Mineral analysis of cookies supplemented with mungbean flour:** Mineral analysis of cookies showed that sodium, potassium, iron, magnesium, zinc and manganese content were significantly affected by the addition of mungbean flour. The results showed that mungbean flour has higher minerals content than wheat flour.

**Calorific value of cookies supplemented with mungbean flour:** It was inferred from the results that calorific value was significantly affected by the addition of mungbean flour. Mean values presented in Table 6 have compared the calorific value of different treatments among which the highest calorific value was observed in $T_5$ (501.1) while calorific value of $T_0$ was the lowest (485.0).

These results indicate that increase in protein content, fat content, ash content, fiber content and mineral content cookies after supplementation of mungbean flour leads to the increase in calorific value of the cookies with gradual addition. Similar results were observed in the study of (Akubor and Onimawo, 2003) who found an increasing trend in calorific value by addition of soya bean flour in cookies. Thus, nutritionally good quality products can be made by supplementation of legumes in wheat flour.

**Sensory evaluation of cookies supplemented with mungbean flour:** The sensory characteristics such as color, crispness, taste and surface characteristics were evaluated by a panelists which given the following results. It is clear from the results that color was

Table 4: Physical and chemical analysis of cookies

| | Physical Characteristics | | | Chemical Characteristics (%) | | | | |
|---|---|---|---|---|---|---|---|---|
| Treatments | Diameter | Width | Spread factor | Moisture | Ash | Protein | Fat | Fiber |
| $T_0$ | 25.15$^{d}$ | 5.85$^{b}$ | 42.99$^{e}$ | 1.55$^{d}$ | 0.65$^{e}$ | 5.40$^{e}$ | 21.3$^{e}$ | 0.40$^{d}$ |
| $T_1$ | 24.70$^{e}$ | 5.65$^{c}$ | 43.01$^{d}$ | 1.45$^{d}$ | 1.00$^{d}$ | 7.11$^{d}$ | 21.6$^{e}$ | 0.52$^{cd}$ |
| $T_2$ | 24.75$^{e}$ | 5.75$^{c}$ | 43.04$^{c}$ | 1.15$^{e}$ | 1.11$^{d}$ | 7.66$^{c}$ | 21.8$^{d}$ | 0.62$^{c}$ |
| $T_3$ | 25.70$^{b}$ | 5.75$^{c}$ | 44.69$^{a}$ | 1.90$^{a}$ | 1.23$^{c}$ | 8.75$^{b}$ | 22.8$^{c}$ | 0.74$^{b}$ |
| $T_4$ | 26.55$^{a}$ | 6.00$^{a}$ | 44.25$^{b}$ | 1.60$^{c}$ | 1.35$^{b}$ | 8.75$^{b}$ | 23.4$^{b}$ | 0.84$^{b}$ |
| $T_5$ | 25.45$^{c}$ | 5.95$^{b}$ | 44.27$^{b}$ | 1.52$^{d}$ | 1.45$^{a}$ | 9.30$^{a}$ | 23.7$^{a}$ | 0.95$^{a}$ |

Table 5: Mineral analysis of cookies (mg/100 g)

| Treatments | Na | K | Fe | Mg | Zn | Mn |
|---|---|---|---|---|---|---|
| $T_0$ | 10.4$^{e}$ | 6.9$^{e}$ | 6.14$^{c}$ | 686$^{e}$ | 3.01$^{d}$ | 0.71$^{ab}$ |
| $T_1$ | 10.6$^{e}$ | 7.2$^{e}$ | 6.00$^{c}$ | 621$^{f}$ | 2.20$^{f}$ | 0.50$^{d}$ |
| $T_2$ | 12.1$^{d}$ | 9.3$^{d}$ | 7.60$^{b}$ | 906$^{b}$ | 2.73$^{e}$ | 0.67$^{c}$ |
| $T_3$ | 12.6$^{c}$ | 12.3$^{c}$ | 7.40$^{b}$ | 807$^{d}$ | 3.19$^{c}$ | 0.70$^{bc}$ |
| $T_4$ | 15.2$^{b}$ | 14.5$^{b}$ | 8.46$^{a}$ | 819$^{c}$ | 5.11$^{b}$ | 0.70$^{b}$ |
| $T_5$ | 16.6$^{a}$ | 16.1$^{a}$ | 8.53$^{a}$ | 942$^{a}$ | 5.43$^{a}$ | 0.81$^{a}$ |

Table 6: Energy value of cookies made with composite flour

| Treatments | Energy value (kcal/100 g) |
|---|---|
| $T_0$ | 485.0$^{d}$ |
| $T_1$ | 495.2$^{c}$ |
| $T_2$ | 496.2$^{bc}$ |
| $T_3$ | 500.2$^{ab}$ |
| $T_4$ | 500.8$^{ab}$ |
| $T_5$ | 501.1$^{a}$ |

Note: Means carrying same letters are not significantly different

significantly affected by the addition of mungbean flour. The color of different treatments among which the highest score was obtained by $T_3$ (7.55) while treatment $T_1$ got the lowest scores (7.00). Similar were the findings of Rabaha *et al.*, 2006. Results showed that crisp was significantly affected by the addition of mungbean flour. The highest score was obtained by $T_1$ (7.66) while treatment $T_0$ got the lowest scores (7.16) for crispiness. The highest taste score was obtained by $T_3$ (7.83) while treatment $T_5$ got the lowest scores (6.50) for taste. The surface characteristics of different treatments among which the highest score was obtained by $T_3$ (7.50) while treatment $T_2$ got the lowest scores (6.83) for surface characteristics.

**Conclusion:** In the world public health sector, protein malnutrition is frequently a result of starvation secondary to natural disaster or conflict. By contrast, disease-related malnutrition that includes an inflammatory component is commonly observed in diverse clinical practice settings throughout the world. In developing countries especially Pakistan, protein malnutrition is the serious menace. There is prolific approach to overcome this threat with the supplementation of mungbean in cereal based products since cereals are ample foodstuffs for humankind. Moreover, the product with high protein, minerals and ash content could be obtained by supplementation of mungbean flour.

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