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Mung Bean and Wheat Flour: A Promising Combination for Nutritious Bread

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Abstract

The nutrient composition of bread made from cereal is inadequate to support the body's optimal growth and development. The potential approach in the production of nutrient-dense snack food is blending cereals with the protein rich legume/oil crops. Thus, the goal of this research was to create composite bread made of wheat and mungbeans that is both palatable and nutritionally enhanced. Composite flour was formulated from wheat to mung bean ratio and labeled with a letter A to E 100:0 (A), 50:50 (B), 62.5: 37.5 (C), 75:25 (D), and 87.5 :12.5 (E) using D-optimal mixture design. The samples' approximate composition, functional characteristics, and sensory acceptability were assessed using official standard methods. The result showed that moisture, ash value, and the composite flour's protein content were boosted by incorporation of mung bean to wheat flour. Moreover, statistically non-significant variation in the quantity of calories and fat were obtained from combination of wheat and mung bean flour comparative to 100% wheat flour. Based on the findings of this investigation,, the highest protein content (20.54%) was obtained from a mixture of 50% wheat and 50% mung bean flour. In addition, functional properties such as the water solubility index, bulk density, and water absorption capacity were increased with decreased substitution levels of mung bean flour. The present finding also revealed that good in flour dispersibility was recorded for the blends consisting of 75 percent wheat and 25 percent mungbean flour. The result of the sensory acceptability showed that all developed bread samples were moderately preferred by consumers. Therefore, mung bean is advised for the production of nutritious and acceptable bread.

Keywords: Bread; Mung bean; Wheat; Protein; Composite flour; Sensory acceptability

Introduction

Bread is a type of confectionary that undergoes fermentation. It is mostly manufactured using wheat flour, water, yeast, and salt and is prepared by a series of procedures that include combining, kneading, shaping, proving, and baking (Dewettinck et al., 2008). It is convenient, popular staple food and consumed daily and during holiday by every socioeconomic class in Ethiopia [1]. There are differences in bread's weight, shape, color, softness, hardness of the crust, and eating quality. Wheat, the most well-known cereal, is capable of generating gluten forming proteins and used mostly to make bread, pasta and various bakery products. The primary factor influencing the product making potential of wheat is the quantity and quality of its storage proteins. Wheat endosperm contains proteins, carbohydrates, soluble fiber, iron, and B-vitamins like riboflavin and niacin and trace minerals (Iqbal et al., 2022) [2].

However, wheat lacks essential amino acids like lysine and threonine, making its nutritional composition inadequate for the human body's ideal growth and development (Siddiqi et al., 2020). Complementation of wheat flour with the protein rich legume/oil crops have gained considerable attention for the production nutrient rich bakery products (Ayo and Olawale, 2003; Badifu et al., 2005) [3]. This might be due to an abundant essential amino acid and high protein content present in the oilseeds and legume crops (Banureka and Mahendran, 2009). Mung bean is an important legume crop used as dried seeds, forage pods and grown primarily in the semi-arid tropics [4].

It is a virtuous source of abundant nutrients and rich in proteins, vitamins, minerals, essential fatty acids and antioxidants (Kollarova et al., 2010; Mubarak, 2005; Akaerue and Onwuka, 2010). Mungbean seeds comprise nearly 20.97–31.32% protein which is double to that of cereal seeds (Anwar et al., 2007; Galova et al., 2011). Furthermore, mung beans are widely recognized for their strong antifungal, antibacterial, and anti-inflammatory properties, in addition to their ability to fight cancer, diabetes, and hypertension (Shahrajabian et al., 2019). Mung bean is widely consumed as whole grains, bean sprouts, noodles, and mung bean paste throughout East and Southeast Asia, and also more frequently eaten as bean stew in East Africa (Mohan Naik et al., 2020; Nair and Schreinemachers, 2020) [5].

It was also reported by Kenawi et al., (2009) that mung bean flour can be utilized as meat extender in buffalo meat products. Mung beans have so emerged as a significant, high-protein component in a variety of culinary uses, including baked goods. Bread made from a blend of wheat and mung bean composite flour has the potential to address food poverty and protein-energy malnutrition by offering a cost-effective and nutrient-dense product. Thus, the goal of this research was to create nutrient-dense, palatable bread using composite flour made of wheat and mung beans [6].

Materials and Methods

Collecting and preparing samples

Wheat (Shorima variety) was provided by Kulumsa Agricultural Research Center. The sample was then gathered, processed, and

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washed to get rid of any extraneous objects. The Melkassa Agricultural Research Center provided the chosen mung bean variety, N-26, which was then sorted, washed, soaked for an overnight period, and dried. A cyclone sample mill (Model: 3010-019) was used to grind both wheat and mung beans [7].

Formulations of composite flours of wheat and mung-bean.

The composite flour was formulated using design expert software and minitab as shown in Table 1. 100% Wheat sample (control) and represented as a letter A.

Bread preparation procedure

Flat bread was prepared following the home-made traditional procedure. To proceed the initial steps, prepared composite flour was mixed with water by adding baking powder. Then, the dough was kneaded in well manner for certain minutes. After kept it upto 4 hours at room temperature for fermentation, the dough was rolled out onto a firm wooden board that had been lightly dusted with flour [8]. Then, it was baked, drizzled the griddle with a little oil and cooked for 3 to 4 minutes per side. The prepared bread was then served for sensory evaluation. Some parts were dried, milled, and sealed in polyethylene bags so that its proximate makeup could be ascertained (Table 1) [9].

Determination of proximate composition

The contents of moisture, total mineral, crude fat, fiber, and protein were determined following standard method (AOAC, 2010). The carbohydrate was calculated by difference method (James, 1995).

Functional properties

Bulk density of the flour: The bulk density detemination approach developed by Narayana and Narasinga-Rao (1984) was mentioned by Edema (2005) was used in this study. 50 grams of the sample were put into a measuring cylinder with a capacity of 100 milliliters. To get a constant volume, the cylinder was tapped on a lab bench many times. The volume of the sample was then recorded. The bulk density was calculated by dividing the weight (g) of the milled flour by its volume (cm3) [10].

Water absorption capacity of the flour

The approach described by Sosulski (1962), which was mentioned by Ayinadi et al. (2010), was used to calculate WAC. A sample of 3g composite flour (w1) in a weighted centrifuge tube (w2) is mixed six times for one minute at intervals of ten minutes, using 25 ml of distilled water in between. The clear supernatant was decanted and disposed of after the mixtures were centrifuged for 25 minutes at 3000 rpm. Drying was done on the pellets for 25 minutes at 50°C. After removing the clinging water droplets, the weight was measured again (w3). Weight increase was used to calculate the quantity of water absorbed in the sample and was reported as water retention. One way to represent the water absorption capacity was as the weight of water bound by 100 grams of dried flour [11].

Table 1: Composites flour formulation.

Blends	% Wheat	% Mung bean
A	100	0
B	50	50
C	62.5	37.5
D	75	25
E	87.5	12.5

The flours' dispersibility property

The dispersibility was ascertained using Kulkarni's (1991) approach, which Edema (2005) mentioned. A 100 ml measuring cylinder was filled with 10 g of flour sample. To a 100 ml amount, distilled water was introduced. After giving the sample a good shake, it was given three hours to settle. The volume of settling particles was measured and deducted from 100 to get the percentage dispersibility of the difference [12].

Sensory evaluation of the bread

Semi-trained panelists consisting of 25 members using 5- point hedonic scales were used to evaluate the colour, aroma, texture, taste, and overall acceptability of bread. A number was used to indicate the degree of the hedonic scale: 5 meant very much like, 4 meant like, 3 meant neither like nor dislike, 2 meant dislike, and 1 meant dislike very much [13].

Statistical analysis

SAS Statistical software was used to evaluate all of the triplicate data for the sensory characteristics of the bread as well as its proximate composition and functional aspects. To separate the means, the data were put via a one-way analysis of variance (ANOVA) and the LSD test [14].

Results and Discussion

Composition of the flour

Table 2 presents the composition study results of the flour. According to the statistical analysis, there was a substantial ($P<0.05$) variation in the moisture content of the composite flour across several treatments. The composite flour made from 50% wheat and 50% mung beans had the maximum moisture level (9.41%), whereas 100% wheat flour had the lowest moisture content (8.32%). The range of moisture content found in this investigation was less than 10% which is good for longer shelf life. According to Alozie et al. (2009), it was illustrated that the low moisture products have stable and longer shelf stability [15].

Ash content referred a total of minerals concentration present in any given food staff. The total mineral content (ash) of the composite flour in this investigation was ranged from 1.75% for 100% wheat flour to 3.15% for composite flour consisting of 50% wheat and 50% mung bean flour. It was increased with increased level of mung bean flour. This result is closely related to the ash value reported by Igbabul et al., (2014) for bread produced from wheat, maize and orange fleshed sweet potato [16].

Crude fibre is a component of dietary fiber and helps maintain the gastrointestinal system's health, type 2 diabetes, colorectal cancer and prevent constipation in human being (Chhabra, 2018). The result of fiber content was ranged from 2.47% recorded for composite flour having 75% wheat and 25% mung bean flour to 7.68% noted in 100% wheat flour. It showed decrement as substitution level of mung bean increased. Decreasing of crude fiber could be due to the lower source of crude fiber in mung bean relative to wheat flour [17]. The protein value of wheat-mung-bean composite flour was ranged from 13.36% for 100% wheat flour to 20.54% for composite flour developed from mixing 50% wheat and 50% mung bean flour [18].

The protein result in the current study enhanced with an increasing level of Mung bean flour. This indicated that complementation of wheat flour with mung bean contributed to enhance the protein content of the composite flour. It has been reported that mung beans provide a significant protein source (Dahiya et al., 2015). The highest protein content (20.54%) obtained in the present study was noted for composite flour produced from equal proportion wheat and mung bean flour. Protein content obtained by incorporation upto 25% of mung bean flour resulted greater protein content than that of reported by Nanyen et al., (2016) for composite flour blended from 50% wheat, 20% acha and 30% mung bean flour [19].

The flour were not different (P<0.05) in terms of caloric value and crude fat content. The composite bread had lower moisture, ash, protein, fat and fiber contents than that of composite flour. This might be contributed to the effects of thermal processing on bread occurred during bread baking. The carbohydrate and energy value were higher in composite bread than that of composites (Table 2) [20].

The result of this study showed that formulations C and D had superior protein content of 18.70 and 18.61, respectively. There were notable variations in the carbohydrate content (P<0.05) across several mixes of wheat and mung bean composite flours. The control samples exhibited highest content of carbohydrate (67.59 whereas the lowest value 60.02% was recorded for 50% wheat and 50% mung bean composites. It could be attributed to high starch content of wheat. This result is in agreement with the carbohydrate content reported by Dabels Nanyen et al. (2016) for composite flour produced from wheat, acha and mung bean flour. The current investigation further shown that there was a statistically insignificant (p~0.05) variation in the energy value of the composite flour [21].

Functional properties of the composite flour

Table 3 presents composites' functional properties. Functional properties illustrated the characteristics of food components during processing, as well as their effects on final products' appearance, texture, structure, color, and flavors (Awuchi et al., 2019). Bulk density of a food indicates its relative volume or capacity. It shows a food product's porosity, which affects the package design and helps identify the kind of packaging material needed (Iwe et al., 2016). The higher the bulk density of flours, the more suitable it is in food preparation. Conversely, low bulk density flours are preferable complementary foods formulation (Suresh and Samsher, 2013) [22].

Some result of bulk density obtained in present investigation was in the range of 0.73 to 0.94 gm/mL. According to Peter-Ikechukwu et al. (2018), the bulk density of water melon meal and wheat based composite flour was found to be 0.71 to 0.79gm/mL. It was observed that bulk density, water solubility index and water absorption capacity were notably increased (P<0.05) with decreased substitution levels of mung bean. This indicated that an incorporation of mung bean flour in wheat flour could enhance such functional properties. The term water absorption capacity refers the flour's capability to swell and absorb water, and important to predict food's consistency, yield, viscosity, appearance, and dough handling (Iwe et al., 2016).

As can be observed from Table 3 the composite flours' water absorption capacity ranged from 117.5% for 100% wheat flour to 145.1% for composite flour consists 62.5% of wheat and 37.5% of mung bean flour. According to Bello et al. (2017) capacity of flour to absorb water is significantly affected by their levels of protein and carbohydrate. In the current study the result of water solubility index of composite flour presented in Table 3 varied over 5.82% for 100% wheat flour to 14.11% for composite flour developed from 50% wheat and 50% mung bean flour (Table 3) [23].

The ability of flour sample to disperse in water and produce a fine component during mixing is measured by its dispersibility; the higher the dispersibility indicates the sample will reconstitute easily and provides a fine consistency dough (Adebowale et al., 2011). The dispersibility was decreased significantly for all formulated composite flour other than that of formulated from a mixture of 75% wheat and 25% mung bean flour. The highest dispersibility (75.33%) was recorded for composite flour consists 75% of wheat and 25% of mung bean flour which showed good in flour dispersibility respective to the remaining composite flour.

Table 2: Proximate composition of the composite flour in percent (%).

Blends	Moisture	Ash	Protein	Fat	Fiber	CHO	Energy (Kcal/100g)
A	8.32^{c}	1.75^{c}	13.36^{d}	1.29^{a}	7.68^{a}	67.59^{ab}	335.47^{a}
B	9.41^{a}	3.15^{a}	20.54^{a}	1.15^{a}	5.72^{ab}	60.02^{c}	332.59^{a}
C	8.69^{bc}	3.14^{a}	18.70^{b}	1.11^{a}	3.52^{ab}	64.83^{b}	344.12^{a}
D	9.16^{ab}	2.60^{b}	18.61^{b}	1.21^{a}	2.47^{b}	65.95^{ab}	349.18^{a}
E	9.02^{ab}	2.41^{b}	15.37^{c}	1.23^{a}	2.79^{b}	69.16^{a}	349.31^{a}
CV	*3.48*	*10.63*	*1.71*	*9.56*	*5.87*	*3.56*	*2.72*
LSD	*0.56*	*0.5*	*0.54*	*0.2*	*4.27*	*4.24*	*16.94*

Means within the same column followed by the same letter are not significantly different at p=0.05 level. CV = Coefficient of variance, LSD = Least significant difference, A= 100% wheat, B= 50% wheat and 50% mung bean, C= 62.5% wheat and 37.5 mung bean, D= 75% wheat and 25% mung bean, E= 87.5% wheat and 12.5% mung bean, CHO=Carbohydrate

Table 3: Composite flours' functional properties.

Blends	Bulk Density(g/ml)	Water absorption capacity	Water solubility index	Dispersibility
A	0.73^{d}	117.50^{b}	5.82^{d}	72.00^{b}
B	0.94^{a}	144.53^{a}	14.11^{a}	68.17^{d}
C	0.84^{b}	145.10^{a}	10.97^{b}	63.00^{e}
D	0.81^{b}	139.07^{a}	11.32^{b}	75.33^{a}
E	0.82^{b}	137.30^{ab}	7.98^{c}	70.67^{c}
CV	*2.99*	*8.35*	*7.1*	*0.55*
LSD	*0.05*	*20.76*	*1.29*	*0.69*

Means within the same column followed by the same letter are not significantly different at 0.05 level. CV = Coefficient of variance, LSD = Least significant difference, A= 100% wheat, B= 50% wheat and 50% mung bean, C= 62.5% wheat and 37.5 mung bean, D= 75% wheat and 25% mung bean, E= 87.5% wheat and 12.5% mung bean

Table 4: Sensory evaluation of wheat and mung bean bread.

Blends	Color	Aroma	Texture	Taste	Overall acceptability
A	3.85^{ab}	3.52^{a}	3.19^{a}	3.52^{ab}	3.52^{b}
B	4.28^{a}	3.57^{a}	3.14^{a}	3.09^{b}	3.71^{ab}
C	4.24^{a}	3.76^{a}	3.67^{a}	3.85^{a}	3.85^{ab}
D	3.67^{b}	3.81^{a}	3.66^{a}	3.62^{ab}	3.85^{ab}
E	4.33^{a}	3.47^{a}	3.47^{a}	3.62^{ab}	4.24^{a}
CV	6.83	10.9	9.56	9.77	9.66
LSD	0.51	0.72	0.6	0.63	0.67

Means within the same column followed by the same letter are not significantly different at 0.05 level. CV = Coefficient of variance, LSD = Least significant difference, A= 100% wheat, B= 50% wheat and 50% mung bean, C= 62.5% wheat and 37.5 mung bean, D= 75% wheat and 25% mung bean, E= 87.5% wheat and 12.5% mung bean

Sensory analysis of composite bread

Table 4 displayed the results of the sensory analysis of the bread made with a composite flour of wheat and mung beans. The color, fragrance, texture, taste, and general acceptance of the bread were assessed. Based on statistical analysis, there was a substantial difference in the color of the bread samples. Color is the most important sensory attributes which affects consumer and customer preference to foods. The bread sample having 87.5% of wheat and 12.5% mung bean was ranked first by panelists with 4.33 and followed by 50% wheat and 50% mung bean (4.28), 62.5% of wheat and 37.5 mung bean (4.24), 100% wheat flour (3.8573) and 75% wheat and 25% mung bean (3.67) in terms of color score.

The 62.5% wheat and 37.5% mung bean had high value of texture (3.67) and taste (3.85). In the current investigation, the bread sample made with various combinations of wheat and mung bean composite flour demonstrated non-significant ($p > 0.05$) in texture and aroma [24].

In terms of overall acceptability and taste, the composite bread consisting 62.5% wheat and 37.5% mung bean received the highest similar score of 3.85. The sensory evaluation result of wheat and mung bean composite bread showed that different blends exhibit variations in color, aroma, texture, taste, and overall acceptability.

According to Igbabul et al. (2016), samples of bread were made by blending wheat flour with acha and mung bean flours in different ratios were well accepted by the testers. Up to 40% of wheat flour replacement by faba bean flour for bread development resulted in acceptable sensory quality (Benayad et al., 2021). In the current study it was possible to develop a bread with up to 50% mung bean without compromising sensory quality (Table 4) [25].

Conclusions

The present study has shown incorporation of mung bean flour with wheat flour contributed to an increment in nutrient content of the composite flour. Some functional properties of composite flour were enhanced by substitution of mung bean to wheat flour. Panelists expressed a high level of acceptance for the organoleptic qualities of all bread made with wheat-mung bean composite flour. Moreover, nutrient dense and highly acceptable bread was prepared from composite flour consisting of 87.5% wheat and 12.5% mung bean flour. Therefore, the use of mung beans in substitution of wheat could be recommended in the production of nutritious and acceptable bread for desired targeted group.

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