Evaluation of Traditional Bread Prepared from Wheat, Cowpea and Mung Bean Composite Flours

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Abstract

This experiment was conducted to evaluate traditional flat bread prepared from composite flours of wheat, cowpea and mung bean. Standard methods of analysis were used to determine physicochemical characteristics, functional properties and mineral contents. Five-point hedonic scale was used to evaluate the sensory qualities of the bread. According to the results, the traditional bread prepared from composite flours of wheat and cowpea/mung bean was within acceptable limits for all sensory attributes. However, there were significant differences in proximate composition, mineral content and sensory properties at different incorporation levels of cowpea/mung bean. Iincorporation of more than 12.5% cowpea/mung bean in wheat can contribute to the increment in protein and total mineral contents of the bread. Moreover, the use of cowpea and mung beans in substitution of wheat can enhance utilization of legumes and improve nutrition security.

Introduction

Bread is a major staple wheat based food product, which has gained wide acceptance among consumers in the world (Badifu *et al*., 2005). Supplementation of cereal-based foods with other protein sources such as legumes has gained considerable attentions in the recent time (Oluwole and Olapade, 2011). Cowpea and mung beans are important legume crops used as dried seeds and forage pods. Cowpea (*Vigna unguiculata*), also known as black eyed bean, southern pea and Crowder pea, is an annual dual purpose legume that grows in the semi-arid tropics covering Africa, Asia, Central and South America, being a valuable component of traditional cropping systems for human food and livestock fodder (Singh et al., 2003). The usefulness of cowpea (*Vigna unguiculata*) in developing high protein foods and meeting the needs of the vulnerable groups of the population is now well recognized globally (Olapade 2010 and Olapade *et al*., 2011). Several reports have indicated enrichment of wheat flour for baking. Including addition of fluted pumpkin flour (Giami, 2003), lentil and faba bean flours (Hsu *et al*., 1982), chick pea flour (Fernandez and Berry, 1989), soy flour (Misra *et al*., 1991), sunflower flour (Yue *et al*., 1991), winged bean flour (Kailasaptty *et al*., 1985) and mung pea flour (Finney *et al*., 1982).

Mung beans (*Vigna radiata* L. Wilczek), on the other hand, are pulses or food legume crops used primarily as dried seeds and occasionally as forage or green pods and seeds for vegetables (Tomooka, 2002). As a food, mung beans contain balanced nutrients, including protein and dietary fiber, and significant amounts of bioactive phytochemicals. It is an excellent source of high quality protein and is one of the cheapest and richest sources of plant protein (Akaerueand Onwuka, 2010). High levels of proteins, amino acids, oligosaccharides, and polyphenols in mung beans are thought to be the main contributors to the antioxidant, antimicrobial, anti-inflammatory, and antitumor activities of this food and are involved in the regulation of lipid metabolism. Consumption of mung bean supplemented products can fulfill requirements of essential amino acids (Iqbal *et al*., 2006). It has been suggested by Kenawi *et al*. (2009) that mung bean-wheat flour blends can be used as alternate or in combination with other ingredients in many food products.

Despite their economic and social importance, cowpea and mung bean are underutilized in Ethiopi. In addition, this received relatively little attention from a research standpoint. Carbohydrate source foods are most common in the country and animal origin proteins are not in the reach of many households. Developing nutrient-dense, affordable and accessible food products from locally produced ingredients is a viable and sustainable approach to address the problem of malnutrition. Thus, the objective of this study was to develop cowpea and mung bean based-bread to alleviate the problem of specially protein malnutrition in the country.

Materials and methods

Ingredient collection and preparation

Grains of bread wheat variety *Shorima* were collected from Kulumsa Agricultural Research Center. Similarly, cowpea variety *Bole* and mung bean variety *N-26* were collected from Melkassa Agricultural Research Center. The legumes were soaked overnight and dried. All the grains of wheat, cowpea and mung bean were milled into flour using cyclone sample mill (Model: 3010-019).

Formulations of composite flours of wheat, cowpea and mung bean

Wheat, cowpea and mung bean flours were formulated using design expert 14. Table 1 presents actual proportions of the flours. Cowpea and mung bean replaced wheat flours alternatively and evaluated in comparison with 100% wheat (control) which represented as Run_3 in both cowpea and Mung bean formulations.

Functional properties of composite flours

Bulk density of the flour: was determined based on the methods used by Narayana and Narasinga-Rao (1984) as cited by Edema (2005). A mass of 50 g of the sample was put in to a 100 ml measuring cylinder. The cylinder was continuously tapped on a laboratory bench until a constant volume was obtained. Then, the volume of sample was recorded and bulk density was calculated as weight of the ground flour (g) divided by its volume (cm^3).

Water absorption capacity (WAC): was determined with the method reported by Sosulski (1962) as cited by Ayinadis *et al. (*2010). A 25 ml of distilled water was added to a sample of 3g composite flour (w_1) in a weighed centrifuge tube (w_2). This stirred six times focvr 1 min at 10 min intervals. The mixtures were centrifuged at 3000 rpm for 25 min and the clear supernatant was decanted and discarded. Pellets were dried at 50^{o}C for 25 min. The adhering drops of water were removed then reweighed (w_3). The amount of water retained in the sample was recorded as weight gain and was taken as water absorption and expressed as the weight of water bound by 100 g dried flour.

Dispersibility: was determined by the method of Kulkarni (1991) as cited by Edema (2005). A 10 g of flour sample was weighed into a 100 ml-measuring cylinder. Distilled water was added up to 100 ml volume. The sample was vigorously stirred and allowed to settle for 3 h. The volume of settled particles were recorded and subtracted from 100 to get the difference that was taken as percentage dispersibility.

Bread making process

For preparation of traditional flat bread, flour and other ingredients were mixed and dough was well kneaded, and flattened on a hard wooden surface sprinkled with a small quantity of flour. Then it was baked on a hot pan, drizzled the griddle with oil and cooked for 3 to 4 minutes per side. The prepared breads were then taken for sensory evaluation and representative samples were dried, milled and packed in polyethylene bags for nutritional composition analysis.

Sensory evaluation

Bread prepared using wheat and cowpea/mung bean flour blends were subjected to a sensory evaluation. Each bread sample was evaluated by a semi-trained panel (a panel briefed about scoring of sensory attribute) of 25 people. Since the panelists were not fully trained, and to make the evaluation process consistent, a simple 5-point hedonic scale was used, where five stands for like very much and 1 for dislike too much, for each sensory attribute. The sensory attributes evaluated were color, aroma, texture, taste, and overall acceptability.

Proximate composition analysis

Methods developed by Association of Official Analytical Chemists (AOAC, 2010) were used to determine crude protein, crude fat, crude fiber, moisture and ash contents of both the crops (wheat, cowpea and mung bean) and bread samples. Total carbohydrate was estimated by difference method.

Mineral content analysis

For mineral content analysis, the samples were prepared using dry and ashing method as described by Jones *et al.* (1990). Atomic Absorption Spectrophotometer determined minerals including calcium, magnesium, sodium, potassium, iron, zinc, copper and manganese.

Statistical analysis

All analyses were carried out in triplicate and data were analyzed using SAS statistical software and ANOVA. Differences among means were tested for significance at $P < 0.05$ level and, thus; LSD test was employed to separate treatment means.

Results and Discussion

Proximate composition of composite flours

The proximate composition of wheat and cowpea/mung bean composite flours is presented in Table 2. Except for fiber, content in wheat-cowpea and fat content in wheat-mung bean flours, which were not significant; all the formulations were found to be significantly different ($P < 0.05$). Protein and ash contents of the composites increased with an increasing substitution level of cowpea/mung bean flour, which might be due to the high protein and mineral contents of cowpea/mung bean. The highest and lowest protein and ash contents were recorded for wheat to cowpea/mung bean ratio of 50:50 and 100:0, respectively. In line with this, Nanyen *et al.* (2016) have reported protein value of 17.5% in a flour blend of 50% wheat, 20% acha and 30% mung bean. The highest carbohydrate content was recorded in 100% wheat sample that might be due to the starchy nature of cereals in general and that of wheat in particular. The influence of cowpea and mung bean on proximate composition of the composite flour was similar. Moisture content of the composite flours was in the range between 7.3 and 9.8%, indicating longer storage life of the ingredients.

Means with the same letter in a column are not significantly different (p>0.05); T1=50% wheat & 50% cowpea/mung bean, T2= 62.5% wheat & 37.5% cowpea/mung bean, T3= 100% wheat, T4=87.5% wheat & 12.5% cowpea/mung bean and T5=75% wheat & 25% cowpea/mung bean; CV=coefficient of Variance, LSD=least significant difference

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Functional properties of composite flours

Functional properties are the fundamental physicochemical properties that reflect the complex interaction between the composition, structure, molecular conformation and physico-chemical nature of food components together with the nature of environment in which these are associated and measured (Siddiq *et al*., 2009). The functional properties (bulk density, water absorption capacity (WAC), water solubility index (WSI) and dispersibility) of the composite flours were significantly affected by the treatments ($P < 0.05$) (Table 5). Bulk density of flour is the density measured without the influence of any compression, and the result of composite flours in the current study ranged from 0.728 to 0.947 g/cm^3. High bulk density of flours suggests their suitability for use in food preparations. In contrast, low bulk density would be an advantage in the formulation of complementary foods (Akapata and Akubor, 1999). WAC is the ability to hold its own and added water during application of force, pressing, centrifugation or heating. WAC of the composite flours in this study ranged from 117.5 to 145.6%. The increase in WAC is always associated with increase in the amylose leaching and solubility, and loss of starch crystalline structure. The flour with high water absorption may have more hydrophilic constituents such as polysaccharides (Butt and Batool, 2010). WSI determines the amount of free molecules leached out from the starch granule with addition of excess water (Ortiz *et al.*, 2010). Despersibility value of the composite flours ranged from 60.2 to 75.3%. A study by Singh *et al*. (2003) indicated that the functional properties of flours are affected by their morphology, processing and composition. The authors also explained that the lipids of wheat are present at lower levels and significantly affect the swelling and water absorption of starch. Furthermore, the technological quality of proteins is also related to the water absorption of the flours.

WAC=water absorbing capacity and WSI=water solubility index; Means with the same letter in a column are not significantly different (P > 0.05); T1=50% wheat & 50% cowpea/mung bean, T2= 62.5% wheat & 37.5% cowpea/mung bean, T3= 100% wheat, T4=87.5% wheat & 12.5% cowpea/mung bean and T5=75% wheat & 25% cowpea/mung bean; CV=coefficient of Variance, LSD=least significant difference.

Sensory evaluation of bread

Results of sensory evaluation of the bread prepared from wheat and cowpea and from wheat and mung bean composite flours are presented in Table 6 and Table 7, respectively. Generally, breads made up of composite flours of wheat and cowpea/mung bean were within acceptable limits, more than three, for all sensory attributes. Results the statistical analysis showed that bread samples were significantly different in their color, taste and overall acceptability (P < 0.05). It was observed that addition of up to 50% cowpea/mung bean to wheat had no significant effect on the texture of breads.

Treatment	Color	Aroma	Texture	Taste	Over-all acceptability
1	3.43^{C}	3.71^{A}	3.71^{A}	3.57^{AB}	3.90^{A}
2	4.05^{AB}	3.19^{B}	3.29^{A}	3.05^{B}	3.52^{B}
3	3.95^{ABC}	3.76^{A}	3.67^{A}	3.67^{AB}	4.00^{A}
4	4.29^{A}	3.86^{A}	3.67^{A}	4.00^{A}	3.81^{AB}
5	3.71^{BC}	3.57^{AB}	3.52^{A}	3.29^{AB}	3.76^{AB}
Mean	3.89	3.62	3.57	3.51	3.80
C.V.%	7.65	6.53	9.80	11.30	4.55
LSD	0.54	0.43	0.64	0.72	0.31

Means with the same letter in a column are not significantly different (p>0.05); T1=50% wheat & 50% cowpea/mung bean, T2= 62.5% wheat & 37.5% cowpea/mung bean, T3= 100% wheat, T4=87.5% wheat & 12.5% cowpea/mung bean and T5=75% wheat & 25% cowpea/mung bean; CV=coefficient of Variance, LSD=least significant difference.

Treatment	Color	Aroma	Texture	Taste	Over all acceptability
1	4.29^{A}	3.57^{A}	3.14^{A}	3.10^{B}	3.71^{AB}
2	4.24^{A}	3.76^{A}	3.67^{A}	3.86^{A}	3.86^{AB}
3	3.86^{AB}	3.52^{A}	3.19^{A}	3.52^{AB}	3.52^{B}
4	4.33^{A}	3.48^{A}	3.48^{A}	3.62^{AB}	4.24^{A}
5	3.67^{B}	3.81^{A}	3.67^{A}	3.62^{AB}	3.86^{AB}
Mean	4.08	3.63	3.43	3.54	3.84
C.V.%	6.83	10.90	9.56	9.77	9.66
LSD	0.51	0.72	0.60	0.63	0.67

Means with the same letter in a column are not significantly different (p>0.05); T1=50% wheat & 50% cowpea/mung bean, T2= 62.5% wheat & 37.5% cowpea/mung bean, T3= 100% wheat, T4=87.5% wheat & 12.5% cowpea/mung bean and T5=75% wheat & 25% cowpea/mung bean; CV=coefficient of Variance, LSD=least significant difference.

Proximate composition of bread

Proximate composition of breads prepared from wheat and cowpea/mung bean composite flours are presented in Table 8 and 9. Except for fat content of wheat-mung bean bread, bread samples prepared from all composite flours were significantly different (P < 0.05). Protein and ash contents of the bread samples increased with an increasing substitution level of cowpea/mung bean flour, which might be due to the high protein and mineral contents of cowpea/mung bean. The highest and lowest protein and ash contents were recorded for bread samples prepared from wheat to cowpea/mung bean ratio of 50:50 and 100:0, respectively. In agreement with this, Nanyen *et al.* (2016) have reported protein value of 17.5% in bread prepared from blends of 50% wheat, 20% acha and 30% mung bean. The highest carbohydrate content was recorded for 100% wheat sample that might be due to the starchy nature of cereals in general and that of wheat in particular. The influence of cowpea and mung bean on proximate composition of bread was similar. The moisture content of breads was in the range of 6.3 and 8.1%, indicating longer storage life of the products.

Means with the same letter in a column are not significantly different (p>0.05); T1=50% wheat & 50% cowpea/mung bean, T2= 62.5% wheat & 37.5% cowpea/mung bean, T3= 100% wheat, T4=87.5% wheat & 12.5% cowpea/mung bean and T5=75% wheat & 25% cowpea/mung bean; CHO= total carbohydrate; CV=coefficient of Variance, LSD=least significant difference

Means with the same letter in a column are not significantly different (p>0.05); T1=50% wheat & 50% cowpea/mung bean, T2= 62.5% wheat & 37.5% cowpea/mung bean, T3= 100% wheat, T4=87.5% wheat & 12.5% cowpea/mung bean and T5=75% wheat & 25% cowpea/mung bean; CHO= total carbohydrate; CV=coefficient of Variance, LSD=least significant difference.

Conclusion

Based on their nutritional composition and functional properties, composite flours of wheat and cowpea/mung bean can be regarded as potential ingredients to make food product. It was observed that cowpea and mung bean are equally important to be incorporated in wheat to make bread, other similar products, as traditional breads made from composite flours of wheat, and cowpea/mung bean were within acceptable limits for all sensory attributes. However, there were significant differences in proximate composition, mineral content and sensory properties at different incorporation levels of cowpea/mung bean. In general, incorporation of more than 12.5% cowpea/mung bean in wheat can contribute to the increment in protein and total mineral contents of the bread. Moreover, the use of cowpea and mung beans in substitution of wheat can enhance utilization of legumes and improve nutrition security.

References

Akaerue BI and GI Onwuka. 2010. Evaluation of the yield, protein content and functional properties of mung bean [Vigna radiata(L.) Wilczek] protein isolatesas affected by processing. Pak. J. Nutr., 9:728-735.

Akapata MI and PI Akubor.1999. Chemical composition and selected functional properties of sweet orange (*Citrus sinensis*) seed flour. Plant Food Hum Nutr., 54:353–362. doi: 10.1023/A:1008153228280.

AOAC.1990. Official Methods of Analysis. Association of Official Analytical Chemists. 15th edn. Washington, D.C. Pp. 205-228.

Butt MS and R Batool. 2010. Nutritional and functional properties of some promising legumes proteins isolates. Pakistan J Nutr., 9(4):373–379. doi: 10.3923/pjn.2010.373.379.

Kenawi MA, RR Abdelsalam, and SA El-Sherif. 2009. The effect of mung bean powder and/or low fat soy flour as meat extender on the chemical, physical and sensory quality of buffalo meat product. Biotechnol. Anim. Husb., 25: 327-337.

Kollarova K, Z Vatehov, L Slovakova, and D Liskova. 2010. Interaction of galactoglucomannan oligosaccharides with auxin in mung bean primary root. Plant Physiol. Biochem., 48: 401-406.

Olapade AA.2010. Physicochemical, sensory and storage properties of extruded acha *(Digitaria exilis)* and cowpea *(Vigna unguiculata)* blends for complementary foods, PhD dissertation, University of Ibadan, Ibadan, Nigeria. 201pp.

Prinyawiwatkul W, KH McWatters, LR Beuchat, and RD Phillips.1996. Cowpea flour: a potential ingredient in food products. CRC. Crit. Rev. Food Sci. Nutr., 36, pp. 413- 436, 1996.

Siddiq M, M Nasir, R Ravi, KD Dolan, and MS Butt.2009. Effect of defatted maize germ addition on the functional and textural properties of wheat flour. Int. J. Food Prop. 12:860- 870.

Singh N, J Singh, L Kaur, NS Sodhi, and BS Gill. 2003. Morphological, thermal and rheological properties of starches from different botanical sources. Food Chemistry, 81, 219-231.