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Determine the Proximate Composition of Pre-Gelatinized Barley Flour Supplemented with Sprouted Fababean and Carrot Powder for Use as Weaning Food.

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Abstract
This study was conducted to determine the proximate composition of pre-gelatinized barley flour supplemented with sprouted faba bean and dried carrot powder for uses as weaning food. Protein energy malnutrition and vitamin A deficiency are the most documented problem in the country of Ethiopia. Developing of weaning foods in the country has a mile stone contribution for this problem. The effect of two factors, blending ratio (barley, faba bean and carrot) and faba bean sprouting duration for days 2 and 3 were studied. The experiment was conducted using custom design by JMP8 software. Mixture response surface methodology was applied for the analysis of data. Optimum value (16.01-16.22%) of protein was obtained at day three when proportion ranged from 50 to 65% barley, 30 to 35% of faba bean and 5 to 10% carrot. The moisture, ash, crude fiber, crude fat , crude protein and carbohydrate content of the blended flours had ranged from 5.30 to 5.48%, 3.30 to 4.09%, 4.85 to 5.38%, 1.41 to 1.48%, 15.71 to 16.22% and 68.11 to 69.66%, respectively. The combined effect of barley, fababean and carrot powder blend were significant ($P<0.0001$) in all the responses analyzed except moisture which was significant at $p< 0.05$. Moisture and protein content had significantly ($P<0.05$) increased with the increase days of fababean sprouting duration. Whereas ash, crude fiber, fat and carbohydrate content significantly ($P< 0.05$) decreased with the increased days of fababean sprouting duration. Supplementing fafabean and carrot to barley (control) significantly ($P< 0.05$) increased the moisture, ash, and crude fiber and protein contents of the blended products and decreased the fat and carbohydrate contents. In general, proportion of barley from 50 to 65%, fababean from 25 to 35% and carrot 10 to 15% were found to be an optimum level for both nutritional and sensory acceptability of the pre-gelatinized barley based weaning foods.
Keywords: weaning food, fat, sprouting, protein, pre-gelatinize

1. INTRODUCTION

Weaning foods can be defined as functional foods which, a product that provides specific health benefits beyond the traditional nutrients they contain or foods containing significant levels of biologically active components that impart health benefits beyond basic nutrition (Drozen, 1998). Weaning foods are meant to be eaten as parts of regular diet. The term was introduced to Japan in the mid 1980s and referred to process foods containing ingredients that aid specific body functions in addition to being nutritious (Halser, 1998).

Studies in Ethiopia showed that about 45% of the children were stunted and about 42% were underweight, in association with protein-energy malnutrition and vitamin A, iodine, zinc, and iron deficiencies (Yimer, 2000). Formulation of weaning food rich in protein, carbohydrate and other nutrient at high proportion to complement breast milk and children less than five ages will bring about the end of the children high mortality rate typically of developing countries (UNICEF, 1998). Weaning foods whether manufactured or locally prepared must satisfy the nutritional requirement of infants and should also be soft and semi-solid in texture. It is mostly prepared in the form of thin porridge or gruels (Silvia *et al.,* 2007). Development of complementary foods is guided by the following principles: high nutritional value to supplement breastfeeding, acceptable, energy dense, low anti-nutritional content and use of local food items. Barley grain is an excellent source of soluble and insoluble dietary fibers and other bioactive constituents, such as vitamin E (including tocotrienoles), B-complex vitamins, and phenolic compounds (Maghulith *et al*., 2006). Recent attention has focused on the potential use of β-glucan from barley and other cereals as a weaning food ingredient (Malkki, 2004). Barley foods are intrinsically qualified to be weaning foods, both for reducing cardiovascular disease risk and for modifying glycemic responses for treatment and prevention of diabetes (Lazaridou and Biliaderis, 2007).

The blend of barley, fababean and carrot could be good weaning foods from the nutritional and health point of view to overcome the problem of protein energy malnutrition and vitamin A deficiency in Ethiopia. Thus, in this research work the properties of weaning food processed from blending of pre-gelatinized barley, sprouted fababean (at day 2 and 3 sprouting) and carrot flours were investigated.

2. MATERIALS AND METHODS

2.1. Experimental Site

Laboratory analysis for proximate composition analysis was conducted at Haramaya University, food science and postharvest technology laboratory.

2.2. Experimental Materials

Hulled barley (*Hordeum vulgari L.*) and faba bean (*vicia faba*) and carrot (*daucus carota L.)* were purchased from local market of the Eastern Haraghe, Ethiopia.

2.3. Experimental Design

A mixture design is appropriate when the response depends on the commodities proportion of the mixture rather than on the commodities quality. In this study the effect of the three mixture of the products namely barley (B), faba bean (Fb) and carrot (C) flour and fababean sprout duration at day 2 and 3 were studied to determine appropriate formulation. The proportion of barley from 50 to 70% fababean from 25 to 35% and carrot from 5 to 15% was used.

2.4. Barley Roasting

About (400 g) barley was conditioned to a moisture content of 10% so as to suppress the differences in moisture content on roasting behavior. The conditioned grain was roasted at 280± 5ºC for 20 second in a traditional sand roaster. The roaster consisted of an iron pan having a diameter of 920 mm and depth of 600mm. the grin was vigorously stirred with the sand to ensure uniformly heating (Sharma *et al., 2010*). It was immediately removed from the hot sand by sieving and spreading on a marble slab for cooling. It was ground in the cyclone sample mill (model 3010-081P, Colorado, USA) to pass through≤ 710µm sieve to obtain roasted barley flour.

2.5. Faba Bean Sprouting

Faba bean grain was soaked in tap water (1:5, w/v) at room temperature (≈ 23ºc) for 12 h. the soaking water was drained off and the grain was allowed to sprout. During sprout, the soaked grains were covered with a moist fine cloth and the container was kept in a dark place at temperature of about (≈ 23 ºc) for 48 and 72 h. the sprouted beans were dried at 50ºC over night in a drying oven(model 101-1A. china)(khalil and Mansour, 1995).

After drying the faba bean was roasted on an iron pan roasting equipment at temperature of 200ºC/ for about 15 min until golden brown color was developed. The processed and dried fababean was grounded to pass ≤ 710µm sieve size and was kept in cool room until used.

2.6. Pre- Treatment and Drying Method of Carrot

The sliced (10mm sizes) carrots were subjected to hot water blanching by holding in a muslin cloth in boiling water (100ºC) for 6 min (Ranganna, 1986) to inactivate peroxidase. The balanced sample was immediately cooled to room temperature under running cold water and then was spread on a sieve tray to drain. After drain the carrot was dried at room temperature of 70ºC for 24 hrs in an oven (model101-1A, china) (Uddin, 2004) and was ground (model A11 basic, IKA, china) to pass ≤ 710µmbsieve size.

2.7. Proximate composition

After bringing the samples to uniform size by a sieve, they were analyzed for moisture, protein, fat, ash, fiber and utilizable carbohydrate by the methods of AOAC (2000).

2.7.1. Moisture

Moisture was determined according to Method number 44-15A) by oven drying method. 5 g of well-mixed sample was accurately weighed in clean, dried crucible (W_1) and the weight of both recorded (W_2). The crucible was placed in an oven at 100-105ºC for 6-12 h until a constant weight was obtained. Then the crucible was placed in the desiccators for 30 min to cool. After cooling, it was weighed again (W_3). The percent moisture was calculated by following formula:

$$\mathrm{MC} = \left(\frac{W_2 - W_3}{W_2 - W_1}\right) \times 100$$

Where: MC = Moisture content of sample (%), W_1 = Mass of dish (g), W_2 = Mass of Sample and dish before drying (g), W_3 = Mass of sample and dish after drying (g)

2.7.2. Crude protein

The protein content of the sample was determined on the basis of total nitrogen content by the micro kjeldhal method of crude nitrogen determination (AOAC, 2000) using the official method 979.09. The Percent crude protein content of the sample was calculated by using the following formula:

$$\mathrm{N} = \frac{(S - B) * \mathrm{N_{HCl}} \times \mathrm{D} * 14}{M * \mathrm{V}} \times 100$$

$$\mathrm{P} = \mathrm{F} \times \mathrm{N}$$

Where; M= mass of sample, S = Sample titration reading, B = Blank titration reading

N = Normality of HCl, D = Dilution of sample after digestion, V = Volume taken for distillation

0.014 = Milli equivalent weight of Nitrogen. P= percent of protein and F= conversion factor, 6.25.

2.7.3. Crude fat

Ether extract as an estimate of crude lipid was determined using a soxhlet extraction method (AACC, 2000) official method 30.10. The solvent then was evaporated by heating on a steam bath. The flask containing the extracted fat was dried on a steam bath to a constant weight. The percent crude fat was determined by using the following formula:

$$\mathrm{Fat}(\%) = \left(\frac{m_f - m_i}{m}\right) \times 100$$

Where: m_f is dried mass of fat with beaker (g), m_i is a mass of the beaker (g) and m is sample mass (g, db).

2.7.4. Ash

The ash content of the products was determined according to AACC (2000) Method No.08-01. The total ash was expressed as a percentage on dry matter basis as: Percent ash was calculated by following formula:

$$\mathrm{Ash}(\%) = \left(\frac{m_3 - m_1}{m_2 - m_1}\right) \times 100$$

Where: m_1 is the mass of the crucible (g), m_2 is sampled mass with crucible (g) and m_3 is final mass of sample with crucible (g).

2.7.5. Crude fiber

Procedure: The crude fiber content was determined by the non enzymatic gravimetric method as described in AACC (2000) method No. 32-10. The total crude fiber was expressed in percentage as: Calculations were done by using the formula:

$$F = \frac{(m_2 - m_3)}{m_1} \times 100\%$$

Where: F is total crude fiber (%), m_1 is mass of sample (g, db), m_2 is a mass of the sample before ashing (g), and m_3 is mass of sample after ashing (g, db.)

2.7.6. Utilizable carbohydrate

Total carbohydrate was calculated by difference after analysis of all the other items method in the proximate analysis.

CHO= (100 -% moisture + % crude protein + % crude fat + % ash+%crude fiber)

3. RESULTS AND DISSCUSSION

3.1. Proximate Composition

Table.1. Proximate compositions of raw barley and fababean , dehydrated carrot and sprouted fababean

Sample	Moisture (%)	Ash (%)	Crude fiber (%)	Crude fat (%)	Crude protein (%)	CHO (%)
B	9.52±0.02b	2.31±0.04e	5.70±0.08b	2.67±0.06a	12.5±0.31d	67.28±0.46b
Fb	10.84±0.10a	3.30±0.11b	1.29±0.02c	1.51±0.02b	26.57±0.30c	56.45±0.34e
C	5.64±0.02dc	5.46±0.05a	10.97±0.33a	0.98±0.10c	7.42±0.19e	69.55±0.17a
D2	5.64±0.09dc	2.74±0.05c	1.16±0.02c	1.25±0.03d	29.53±0.20b	59.52±0.23d
D3	5.70±0.15c	2.53±0.12d	1.11±0.04c	1.16±0.02e	30.55±0.32a	58.96±0.36d

Values are in Mean ± STD. Means within a column with the same letter are not significantly different (p>0.05).Where: B is barley raw, Fb is fababean raw, and C is dried carrot flour. D2 and d3 are fababean sprouted at 2 and 3.

Table 2.Proximate composition of the blended products

Runs	Ingredients			SD	Moisture (%)	Ash (%)	Fiber (%)	Fat (%)	Protein (%)	CHO (%)
	B	Fb	C							
1	0.7	0.25	0.05	D2	5.30±0.04^{bc}	3.33±0.02^{c}	4.88±0.08^{cd}	1.48±0.02^{d}	15.58±0.10^{d}	69.42±0.09^{cb}
2	0.6	0.35	0.05	D2	5.33±0.04^{bc}	3.36±0.02^{bc}	4.85±0.04^{cd}	1.47±0.02^{ed}	15.77±0.11d^{c}	69.22±0.15^{c}
3	0.5	0.35	0.15	D2	5.34±0.30^{bc}	4.09±0.14^{a}	5.30±0.05^{ba}	1.45±0.01^{ef}	15.71±0.19^{dc}	68.11±0.15^{f}
4	0.55	0.35	0.1	D3	5.42±0.02^{ab}	3.32±0.06^{c}	5.26±0.02^{ba}	1.42±0.01^{f}	16.22±0.10^{a}	68.36±0.17^{ef}
5	0.65	0.25	0.1	D3	5.47±0.00^{a}	3.30±0.01^{c}	5.28±0.01^{ba}	1.43±0.01^{f}	15.86±0.10^{bc}	68.66±0.10^{d}
6	0.55	0.3	0.15	D3	5.48±0.06^{a}	3.31±0.02^{c}	5.38±0.02^{ba}	1.41±0.02^{f}	15.92±0.00^{bc}	68.51±0.06^{ed}
7	0.65	0.3	0.05	D3	5.30±0.09^{bc}	3.30±0.02^{c}	4.89±0.06^{cd}	1.44±0.01^{ef}	16.01±0.10^{ba}	69.06±0.04^{c}
Mean					5.37±0.09	3.43±0.31	5.12±0.24	1.44±0.06	15.86±0.42	68.76±0.55
Range					5.30-5.48	3.30-4.09	4.85-5.38	1.41-1.48	15.71-16.22	68.11-69.66
control	1	0	0	0	5.12±0.05^{d}	2.24±0.06^{d}	4.75±0.01^{d}	2.40±0.00^{a}	10.29±0.06^{g}	75.37±0.26^{a}

Values are in Mean ± STD. Means within a column with the same letter are not significantly different (p>0.05).Where: B is roasted barley, Fb is sprouted and roasted fababean and C is dried carrot flour. CHO is carbohydrate, SD is sprouting duration and D2 and D3 are sprouted fababean at days 2 and 3 respectively.

The combined effect of blending barley, sprouted bean and carrot flours on the pre-gelatinized barley based functional food on moisture was significant ($p<0.05$). Both the linear terms of fababean and carrot were not significant ($p>0.05$) on the moisture content. But the linear terms of barley was significant ($p<0.001$). all the interaction terms B*Fb, B*C, Fb*C were not significant($p>0.05$) on the moisture content. The sprouting duration of D3 has significant ($p<0.05$) effect on moisture content. But D2 sprouting duration has no significant ($p>0.05$) effect.

3.1.1. Ash

The ash content of raw barley, faba bean and dehydrated carrot was 2.31, 3.30 and 5.46% respectively (Table 1). The ash content of fababean sprouted at D2 and D3 were 2.74 and 2.53%. The ash content in raw barley was similar with previous work which was reported from 1.99 to 2.12% (Faraj *et al.,* 2004). Ash content of fababean was in closely agreement with Elsheikh *et al*. (1999) reported (3.09 to 3.57%). The ash content of the blended flours had ranged from 3.30 to 4.09% (Table 2). The ash content of control was 2.24% which was significantly ($p<0.05$) increased on the blending with fababean and carrot. The increased in ash content was due to high ash content of fababean and carrot compared the control. The highest ash (4.21%) content was at D2 when 50% roasted barley, 35% fababean and 15% carrot were blended.

The combined effects of the roasted barley, sprouted fababean and dehydrated carrot blended at different levels on ash content was significant ($p<0.001$). all the linear terms and interaction terms were significant($P>0.05$) on ash content except for barley($p<0.05$).sprouting decreased ash content and this is probably as sprouting progressed minerals that contributed to ash is reduced in the process of soaking and sprouting.

3.1.2. Crude Fiber

The crude fiber content of raw barley, fababean and dried carrot flour were 5.70, 1.29 and 10.97%, respectively and of sprouted fababean of D2 and D3 were 1.16 and 1.11%. Khalil (2001) reported higher value of crude fiber content of raw and germinated fababean with value of 4.99% and 3.00%, respectively, when compared to the result obtained. The lower value of crude fiber may be due to dehulling of fababean. The crude fiber content of the blended products had ranged from 4.85 to 5.38% (Table 2). The crude fiber content of the control was 4.75%. Supplementing barley control with fababean and carrot significantly increased the crude fiber content (Table 2). This is due to the high content of crude fiber in the carrot increased the value of fiber in the blended products. The highest value of crude fiber was obtained at D2 when proportion of barley, fababean and carrot were at 50, 35 and 15%, respectively. The lowest value was at D3 when barley, fababean and carrot were mixed at 60%, 35% and 5%, respectively.

The combined effect of blending (roasted barley, sprouted fababean and dehydrated carrot) and sprouting duration on the crude fiber was significant ($P<0.0001$). The linear term of roasted barley was significant ($P< 0.0001$) on crude fiber content. The effect of linear terms of fababean and carrot, the interaction terms of B*Fb, B*C and Fb*C and the sprouting duration of D3 were significant ($P>0.05$) on crude fiber content. The sprouting duration D3 had significant effect on the crude fiber content ($P<0.05$). The interaction term of B*C has high positive (33) effect on crude fiber contents of the product.

3.1.3. Crude Fat

The crude fat content of raw barley, fababean and dried carrot flour were 2.67, 1.15 and 0.98%, respectively .the crude fat content of the raw barley was reported from 2.13 to 2.4% (Faraj *et al*., 2004. The crude fat content of raw and sprouted fababean at 3 days was 1.13% and 0.99%, respectively (Khalil, 2001). The crude fat content of roasted barley (2.40%) was significantly ($P<0.05$) decreased on blending with fababean and carrot (table) because the crude fat con tent of fababean and carrot flours are lower than barley. The crude aft content of the blended products had ranged from 1.41 to 1.48% (Table 2). High crude fat was obtained at D2 sprouting duration when 70% barley, 25% fababean and 5% carrot were blended and low value was obtained at D3 sprouting duration at the level of 55% barley, 30% fababean and 15%carrot flour blends.

The combined effect of blended product on the crude fat content was significant ($P<0.0001$). the estimated parameters of all linear and interaction terms were not significant($P>0.05$) on the crude fat content except the linear term roasted barley was significant ($P<0.0001$). Sprouting duration D3 ($P<0.0001$), D2 ($P<0.05$) had significant effect on crude fat content. Sprouting duration decreased the level of fat content. The slight decrease in its content during sprouting of fababean might be due to the lipases action on sprouting.

3.1.4. Crude Protein

The crude protein content of raw barley, fababean and dried carrot flour were 12.51, 26.57 and 7.42%, respectively. At D2 and D3 sprouting, the crude protein in the fababean was 29.69 and 30.55%. Alonso *et a*l. (2000) reported the crude protein content of raw fababean was 27%, sprouted at D2 and D3 were 27.3% and 27.6%. Li *et al.* (2001) reported the crude protein content of hull-less barley in the range of 11.5 to 14.2% which is in close agreement with the results obtained. The protein content of the blend (barley, Fababean and carrot) had ranged from 15.71 to 16.22%. All blended products were found to have higher crude protein content than the control (10.29%). This is due to the high content of the crude protein in the faba bean. High protein content was obtained at D3 sprouting duration when the level of the barley, fababean and carrot was at 55%, 35% and 10%.

The combined effect of the blended products on the crude protein was significant ($P<0.0001$). The linear terms of barley ($P<0.0001$) and fababean ($P<0.05$) had significant effect on the crude protein content. The linear terms of carrot, all the interaction terms of B*Fb, B*C and Fb*C and the fababean sprouted at D2 was significant (P>0.05) on crude protein content. The sprouting duration of D3 had significant (P<0.0001) effect on crude protein. Sprouting increased the crude protein contents of fababean when compare the raw beans (Table 1). The increased in protein content was due to the consumption of the other beans components and degradation of the high molecular proteins to simple peptides during sprouting process (Khalil, 2001). The highest positive coefficient of fababean (24.47) indicates that an increased proportion of faba bean in the blended increased the protein content of the pre-gelatinized flour.

3.1.5. Carbohydrate

Dehydrated carrot flour has higher carbohydrate content than barley and fababean raw flour (table). The carbohydrate content of raw fababean was 56.45% which was close agreement with Khalil(2001) with the reported value of 56.92%. Sprouting increased the value of carbohydrate contents as compared to the raw fababean. But a slight decrease in carbohydrate content was observed with an increase of fababean sprouting duration (Table 2). Carbohydrate content of the pre-gelatinized barley based blended functional food had ranged from 68.11 to 69.66%. This was significantly decreased the carbohydrate content of the products on the blending with fababean and carrot. This is due to low carbohydrate content in fababean compared to roasted barley (75.37%) and dehydrated carrot (69.99%).

The combined effect of the blended product on carbohydrate content was significant (P<0.0001). This indicates that the linear term of barley (P<0.0001), linear term of the carrot and the interaction term of B*Fb (P<0.05) has significant effect on carbohydrate content. The sprouting duration of D3 has significant effect (P<0.0001) on carbohydrate content. But D2 sprouting duration has no significant (P>0.05) effect.

4. SUMMARY AND CONCLUSIONS

Fortification of grains and vegetables is an important enrichment of nutrients especially in the developing countries to retard the deficiency of protein energy malnutrition and Vitamin A deficiency. The nutritional value of barley, fababean and carrot blended and effects of the sprouting duration of fababean on the blended products were studied using mixture response surface methodology. The combined effect of barley, fababean and carrot powder blend were significant (P<0.0001) in all the responses analyzed except moisture which was significant at p< 0.05. Moisture and protein content had significantly (P<0.05) increased with the increase days of fababean sprouting duration. Whereas ash, crude fiber, fat and carbohydrate content significantly (P< 0.05) decreased with the increased days of fababean sprouting duration. Supplementing fafabean and carrot to barley (control) significantly (P< 0.05) increased the moisture, ash, and crude fiber and protein contents of the blended products and decreased the fat and carbohydrate contents. The optimum ranges for high crude protein was when 50-65% barley, 30-35% fababean and 5-15% carrot flours are blended.

The difference levels of mixture combination with the corresponding overall acceptability were optimum at 55 to 60% of barley, 25 to 35% fababean and at 15% carrot.

5. RECOMMENDATIONS

- Proportion of barley ranged from 50 to 60% fababean from 25 to 35% and carrot from 10 to 15% are recommended ranged for the nutritional and sensory acceptability of the pre-gelatinized barley based weaning foods.
- Blended of grains (cereals and legumes) with fruits or vegetables deserve to be exercised as weaning food to enrich nutritional quality, increase palatability and consumer acceptability. This will help to address the problem of PEM and VAD and cholesterol related diseases
- Functional or weaning food industry and dietary supplements should be encouraged to be developed in the country to reduce health risks and improve health quality. Also further study is needed in the country on the functional food developments.

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