Effect of Taro Variety and Soybean Blending Ratio on Physicochemical Composition, Functional Properties and Sensory Acceptability of Taro-soybean-carrot Based Complementary Food

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Abstract
In Ethiopia about 45% of the children are undersized and about 42% are underweight, in association with protein-energy malnutrition and vitamin A, vitamin C, iron, iodine, and zinc deficiencies. To reduce the incidence of malnutrition, formulation and development of nutritious complementary food from locally and readily available crops such as legumes in supplementation with cereals or starch roots and tubers are important. This study focuses on processing of nutritious complimentary food from locally available crops such as taro, soybean and carrot, and on the suitability of locally available taro variety for processing infant complementary food. The effect of two factors, soybean blending ratio (35g, 40 g and 45 g) and taro varieties (boloso-1 and local) were analyzed using factorial design by SAS software and control and reference samples were analyzed in triplicates. In this work proximate analysis, some of anti-nutritional factors, beta carotene, some of functional properties, mineral content and sensory acceptability of samples were determined. The proximate analysis of taro based complimentary food showed energy, crude protein, crude fiber and crude fat contents were significantly ($P<0.05$) higher (385.90 to394.94 kcal100g-1, 21.87 to 25.30%, 4.79 to 3.59%, and 9.13 to 10.14 %, respectively) than control samples of two varieties of taro flours (349.98 kcal100g-1, 6.98%, 2.53% and 1.86%, respectively for local taro and 352 kcal100g,-16.62%, 2.29% and 1.63%, respectively for boloso-1taro). However, carbohydrate contents of the two varieties of taro (77. 23% for local taro and 77.75% for boloso-1 taro), ash content of local taro variety (5.28%) and moisture content of boloso-1 taro variety (7.68%) were higher in the control samples than soybean blended samples. There was no significant difference between energy density of commercial complementary food and soybean complimentary flour. However, commercial infant food contains the lowest crude fiber content. Crude protein contents of all blended foods fall within the range of RDA of infant food and the energy contents were above the minimum suggested energy density 370 kcal/100 g (db). All blended foods had greater beta carotene contents than the control samples. This could be due to carrot content in the complimentary flour. The beta carotene content of all complimentary flour met the estimated intake of beta carotene, 63–92 µg RE for breast-fed infants of aged 6–11 Months and 125 µg RE for breast-fed children aged 12–23 Months. Iron, calcium, phytic acid, total penolic, water activity and water solubility index were higher in the complimentary flour than in the control samples of taro varieties. Phytate level in taro used in this study was 33.13 mg/100g for boloso-1 and 34.79 mg/100g for local. The phytate level for soaked, blanched and roosted soybean flour was 80.6mg/100g. The availability of calcium and zinc of all products was below the critical limit in all samples analyzed. Phytate: calcium molar ratio <0.24 and [phytate][calcium]:[Zn] millmol < 0.5. Therefore this shows that phytate level in all samples was favorable for calcium and zinc absorption. Phytate: iron molar ratios > 0.15 is regarded as indicative of poor iron availability. The color acceptance of all gruel was above nether like nor dislik and below extremely like. As degree of soybean blending ratio increased, the color acceptance of the gruels from both varieties had decreased but flavor, taste, and overall acceptability increased. Overall acceptability of all complimentary flour was found to be above "neither like nor dislike" and below "extremely like". Among complimentary flour gruel from boloso-1 taro variety blended with 45 g soybean was found to have better nutritional content, reduced anti-nutritional level and better sensory acceptability.
Keywords: Blending ratio, Carrot, Complementary w food, Functional properties, Micronutrient, Proximate composition, Soybean, Taro.

1. Introduction

Breast milk is a sole and sufficient source of nutrition during the first six months of infant life. Breast milk contains all the nutrients and immunological factors of infants required to maintain optimal health and growth, so it cannot be mimicked in artificial formula (Gastel and Wijngaart, 2005). However, the increased needs of calories, proteins, minerals and other nutrients by the growing child make the introduction of some other food necessary. Complementary foods are mostly prepared in the form of thin porridges or gruels (Silvia *et al*., 2007, Walker, 1990). (Agostoni *et al*., 2008). Even though feeding frequency of complementary food depends on the infant size and age, at least four times daily feeding is recommended (WISHH, 2006). According to DH (1994) complementary food should not be delayed beyond six months of age as this increases the risk of nutrient and energy deficiencies because iron deficiency anemia and rickets is more common in infants complimented after 6 months.

Complimentary foods whether manufactured or locally prepared must satisfy the nutritional requirement of infants and should also be soft or semi-solid in texture (Ugwu, 2009). Development of complementary foods is guided by the following principles: high nutritional value to supplement breastfeeding, acceptable, energy dense, low price, low anti-nutritional content and use of local food items (Dewey and Brown, 2003 and Pelto *et al*., 2003).

However, poor nutritional quality of traditionally prepared complementary food causes malnutrition, infant mortality and morbidity as principal nutritional problem in developing country (Mensa and Hargrove, 2001). Traditional infant foods made of cereals or tubers may be low in several nutrients including protein, vitamin A, zinc and iron. These nutrients are of special importance due to their impact on physical and cognitive development (Neumann *et al.,* 2002).

Furthermore, the bulkiness of traditional complementary foods and high concentrations of fiber and nutrient inhibitors are major factors reducing their nutritional benefits (Michaelsen and Friis, 1998; Urga and Narasimha, 1998). Some studies have shown that growth faltering in children coincides with the introduction of low nutrient density complementaryfood, improper feeding practices and gastrointestinal infections (WHO, 2001). Therefore, formulation of complementary food rich in protein, carbohydrate and other nutrient at high proportion to complement breast milk will bring about the end of the children high mortality rate typically of developing country (UNICEF, 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, and zinc deficiencies (Yimer, 2000). To reduce the incidence of malnutrition, the formulation and development of nutritious complementary food from locally and readily available crops has resaved a lot of attention, stimulating interest, in the use of legumes in supplementation with cereals or starch roots and tubers (Alwinick *et al*,. 1988). This study focuses on processing of nutritious complementary food from locally available crops such as taro, soybean and carrot, and on the suitability of locally available taro variety for processing infant complementary food. The suitability of two taro varieties, specifically boloso-1 and local varieties were studded.

2. MATERIALS AND METHODS

2.1. Sample Collection and Preparation

Taro (*Colocasia esculenta*) boloso-1 and local varieties from Areka Research Center; soybean variety, Afgat, which was released in 2007, was obtained from Hawassa Agricultural Research Center and Carrot (*Daucus carota* L) from Harar market. The taro corm was selected and cleaned then was peeled and steeped immediately in portable tap water at room temperature for 10 min to prevent the browning of the peeled corms. The peeled corms was then washed in portable tap water to remove the surface starch, mucilage and then corm was sliced to 2 mm thickness using a manual kitchen slicer (Ikpeme-Emmanuel *et al*., 2009). The sliced taro was then boiled at 95°C for 30 min to reduce the trypsin and chymotrypsin inhibitors and to remove the acridity significantly (Bradbury *et al*., 1992). After which the water was removed by drying in an oven on aluminum foil lined on perforated aluminum trays at 65 °C for 7 hours (Chinnasarn and Rachada, 2010). The dried taro corms was milled to flour using a hammer mill and then sieved into fine flour particles using a mesh screen sieve of 250 microns size to obtain the pregelatinized taro flour. Soybean seeds were sorted and dirt, stick or/and stones were removed and washed. Cleaned seeds was soaked with cold water for at least 2 hour, blanched for 25 mints at 95 ^{0}C (IITA, 1990). Then sun dried for 2 days. Dried soybeans was roasted until light brown and de hulled and then milled to flour to obtain partially processed soybean flour and then sieved into fine flour particles using a mesh screen sieve of = 710 µm sieve size (Fabiyi, 2006). Carrot was selected and cleaned then was peeled and sliced (10 mm sizes) and subjected to hot water blanching by holding in a muslin cloth in boiling water (950C) for 6 min (Ranganna, 1986) to inactivate peroxidase. The blanched samples was immediately cooled to room temperature under running cold water and then spread on a sieve tray to drain. After blanching the carrot was dried at temperature of 70 0C for 24 hrs in oven (Uddin *et al*., 2004) and the dried carrot was milled to flour using a hammer mill and then sieved into fine flour particles using a mesh screen sieve of 710 µm sieve size.

2.2 Experimental Design

The experiment was made in 2x3 factorial design which has two factors, taro variety and blending ratio (soybean) at three levels. Taro flours (100% bolso-1 and 100% local) varieties were considered as a control. Commercial infant food popular in Ethiopia (Cerifam) was taken as reference. Then, the blends nutrient was planned based on the recommended daily nutrient requirements for infants: energy 400 kcal/100 g of which 30- 45% (13.33 to 20.00 g/100g) from fat, not less than 10% (10 g/100g) from protein and the rest from available carbohydrate. In addition recommended micronutrients composition at 50% supply of fortified complementary foods per 100g: 250 mg calcium, 5.8 mg iron, 4.15 mg zinc and 200 µg RE vitamin A were considered (WHO/ FAO, 2010). The rest 50% are expected to be supplied from breast milk.

2.3. Physicochemical and Functional Analysis

Proximate compositions like moisture content, crude fat and crude fiber were analyzed using standard method (AACC, 200). Crude protein and total ash content were analyzed using AOAC (1995). Carbohydrate contents were determined by differences. Gross energy's of complementary flours were also calculated by using the Atwater's conversion factor, 16.7 KJ/g for protein and carbohydrate and 37.4 KJ/g for fat. The mineral contents were analyzed by the procedure of (AACC, 2000) using an Atomic Absorption Spectrophotometer. Total phenolic and phytate contents were determined by the method used by (Sharma and Gupta, 2010), Wheeler and Ferrel, (1971). The ß-carotene was analyzed by open column chromatography spectrometer method (Rodriguez D.B. 1996). The functional properties like Water Absorption Index, Water Solubility Index and Water Hydration Capacity of complementary flours were also determined by according to Narayana K. and Narasinga M.S. 1984 and Beuchat, L.R. 1977. Water activity of pregelatinized mixed flour was measured to determine the shelf stability of the product

2.4. Sensory Evaluation

Sensory analysis was conducted at University FSPT Laboratory. Sensory panelists were selected from Haramaya University FSPT staffs, Food Science and Technology post graduate and under graduate third year students, who have knowledge in sensory analysis and also 20 mothers from HU campus. A total of 60 male and female panelists were involved in the sensory evaluation. The product was prepared in gruel form for the panel. The gruel was prepared by mixing blended flour with hot water in 50g/200ml proportion and boiled for about 30 min with stirring to uniform consistency. Table spoons were put on the cup for each individual panelist. The sensory attributes; taste, visual color, flavor and over all acceptability were evaluated using a five point hedonic scale rated from 1 (very much dislike), 2 (dislike moderately), 3 (neither like nor dislike), 4 (like moderately) to 5 (very much like) (Lawless and Heyman, 1998).

2.5. Statistical Analysis

All data were analyzed using two factors analysis of variance (ANOVA). Duncan's Multiple Range Test was applied to calculate the level of significance (Steel *et al*., 1997). Mean values were considered at 95% significance level ($P<0.05$). The statistical analyses of the data were conducted using SAS statistical software package.

3. Results and Discussions

3.1. Proximate Composition of Taro based Complementary Flours

Moisture contents of complementary flours were in the range of 6.29 to 7.37% (Table 1). Flours with lower content of moisture (<10%) is suitable for inactivation of microbes as a result the shelf life of flours can be extended. There was significant difference ($P<0.05$) on complimentary foods with different blending ratios and controls, on moisture content. There was no significant difference ($p > 0.05$) among the main factor, taro variety on the moisture content. The moisture content of commercial complementary food (Cerifam) was 3.45%, which was the lowest among food samples processed. The complementary food processed thus demands further drying to lowest moisture content to be compared to the complementary food processed in the industry.

Crude protein content of blended flour indicated in Table 1 ranges from 21.08% to 25.99%, could meet recommended daily allowances (RDA) for protein content (energy from protein content should not be less than 10% of the total energy from the product) (WHO/ FAO, 2010). There was significantly difference ($P>0.05$) on protein contents among different blending ratios. The change in crude protein content was large with increasing soybean proportion due to the high amount of protein (47.26%) in the soybean. The result showed that there was no significant difference ($P>0.05$) in crude protein content among main factor of taro varieties.

The crude fat content of complimentary flour ranges from 9.42 to10.15. If a diet has a very low fat content, children may not be able to get adequate amount of energy because of the bulkiness of the diet. As the energy density of fat (9 kcal/g) which is more than double that of protein and carbohydrate (4 kcal/g). The most important factor influencing energy density is the fat content, (Livesey, 1995). RDA of fat content for infants and young children has been suggested is 30-45% which is 13.33 to 20.00 g/100g of energy in the complementary food (WHO/FAO, 2010). However, none of the complimentary flour met the above recommended values for crude fat content in infants' food. The infant food processed by blending 45 g soybean product would meet the RDA of 10–25% for fat content in the infant food suggested by Guthrie (1989). There was significant difference ($P<0.05$) in crude fat content associated with main factor blending ratio. The highest crude fat content (10.14%) was scored for 45g soybean containing sample and the lowest crude fat content (1.63%) was scored for control sample of boloso-1 taro variety (Table 1). The change in crude fat content was due to the higher amount of crude fat in the soybean (20.05%) than in the boloso-1 (1.63%) and local taro.

Crude fiber content of taro based complimentary food ranges from 3.51% to 4.28%. High dietary fiber observed in the diets can have some beneficial biological effects such as laxative effect on gastro intestinal track increased fecal bulk and help reduce plasma cholesterol level (Okoye, 1992). However complementary foods with low fiber content are very important since it helps in the safety of children considering their stomach capacity. Crude fiber content of all products was not beyond the maximum RDA of crude fiber (5 g per 100 g on a dry weight basis) by WHO/FAO, (2010). There was significant difference ($P < 0.05$) among main factor blending ratios on crude fiber content. The highest crude fiber content was scored for sample containing 45 g soybean and the lowest crude fiber content (0.8%) was scored for commercial product (Table 1).

The result showed the ash content of taro based complimentary food was in between 4.04% and 5.52%. It was showed that there was significant difference ($P<0.05$) in ash content between taro varieties. The ash content of blended product with local taro was higher than the ash content which was scored for blended product with boloso-1 taro variety. This was due to the ash content of local taro (5.28%) which was significantly higher than the ash content of boloso-1 taro variety (4.04%)

The lowest carbohydrate content (49.77%) was scored for 45 g soybean blended product and the highest carbohydrate content (55.60%) was scored for control sample of taro boloso-1 variety (Table 1). Although there is no fixed RDA for carbohydrate intake, FAO/WHO (1998) has recommended an intake of about 50 g per day as being sufficient to meet energy needs. In this regard it seem that the control samples and commercial product could meet this recommendation, while all complimentary flour fall short based on the estimated intake of 65g of complimentary food by an infant per day (Fernandez *et al.,* 2002).

Values of energy showed that complimentary flour had higher energy content (382 to 393 kca/100g) (db) than the control samples (349.98 kcal/100g for local taro and 352.08 kca/100g for boloso-1 taro variety) Walker (1990) suggested an energy density of 370 kcal/100g (db) as the minimum desirable level for infant complimentary foods. The calculated energy densities obtained for the experimental blends were ranged from 387 to 395 kcal/100g and for commercial food was 394.69 kcal/100g (Table 1). This shows that all complimentary flour and commercial food contains above the suggested minimum energy density.

3.2 Mineral and Anti- nutritional Contents of Soybean, Taro and Carrot Blended Products

It was observed that Fe and Zn contents of taro based complimentary foods were in the range between 87.94ppm to 102.21 ppm and 90.62ppm to 96.19 ppm respectively. Zn content of blended product was significantly higher ($P<0.05$) than commercial product. There was significant difference ($P<0.05$) on Fe content among taro based complimentary foods. Iron content increased as the amount of soybean increased and the highest Fe content (102.21 ppm) was scored for local taro variety blended with 45 g soybean containing sample and the least (87.94) was scored for bolos-l taro blended with 35g soybean(Table 2). Fe and Zn contents of all products were met the required amount of Zn and Fe contents (RDA) in the complementary complimentary food (minerals contained in 100 g of the infant complimentary food on a dry matter basis should be at least 50% of RDA of Zn (4.15 mg/100g) and Fe (5.8 mg/100g) contents). Ca content of the complimentary food ranges from22.25mg/100g to 26.26 mg/100g mg/100g. The Ca content (96.17 mg/100g) for commercial product was significantly ($P<0.05$) greater than Ca content of taro based complimentary product as well as control samples. However none of the product met the 50% of RDA of Ca content in infant food (250 mg/100g) (WHO/ FAO, 2010).

The result showed that there was insignificant effect ($P>0.05$) among the main factor taro variety on phytic acid and total phenolic contents. This was due to insignificant difference in phytic acid and total phenolic contents in the two varieties of taro. There were significant difference ($P<0.05$) among main factor blending ratio on phytic acid and total phenolic contents. Phytic acid binds trace elements such as zinc, calcium, magnesium and iron, in the gastrointestinal tract and making dietary minerals unavailable for absorption (Sandberg and Andlid, 2002). Some research observations showed that the absolute effects of high level anti-nutritional factor on mineral bioavailability are dependent on the relative concentration of minerals in such foods, as well as the anti nutritional factors: mineral molar rations of the food. For favorable Ca absorption, phytate: calcium molar ratio < 0.24 (Frontela *et al*., 2009).

3.3 Some Functional properties, Water Activity and Beta-Carotene Content of Soybean, Taro and Carrot Blended Flours

Beta carotene contents (1.65-1.75 mg/100g) of complimentary flour reveled significantly ($P<0.05$) higher than beta carotene content of control samples of taro and commercial food (Table 3). This could be due to the presence of carrot content in the complimentary flour. Fruits and vegetables contain vitamin A in the form of carotenoids, the most important of which is β-carotene (Olson, 1999). RDA of beta carotene content for infants and young children has been suggested is 400 µg/100g (WHO/FAO, 2010). Average levels of intake, human milk would meet 77–84% of RDA for infants aged 6–11 Month and 69% of RDA for children aged 12–23 Month (Jose, 2003). The estimated intake gap would be 63–92 µg RE (16–23% of RDA) for breast-fed infants aged 6–11 Months and 125 µg RE (31% of RDA) for breast-fed children aged 12–23 Months. Therefore, all complimentary flour met the estimated intake gap of beta carotene. The result showed no significant difference

(P>0.05) in beta carotene content due to blending ratio and taro variety.

Water activity of taro based product ranges from 0.54 to 0.57 taro based complimentary products. Water activity is one of the most important factors that significantly influence the shelf life of food products like dried flours. High water activity in products leads to shorter shelf life due to high free water for biochemical reactions and microbial growth. The deterioration of dried powder caused by microorganisms and biochemical reactions can be prevented at a_w lower than 0.6 (Tang and Yang, 2004). The water activity of all products was less than 0.6, so it is safe and prevents biochemical reactions and microbial growth. There was significant difference ($p<0.05$) in water activity among the blending ratio and factor taro variety.

Water absorption index (WAI) taro based taro based complimentary food ranges from 3.23 to 3.69. Complimentary foods with high water absorption index is not desirable for infant feeding as the product would absorb more water and less solid, resulting in low nutrient density for the child. Therefore sample with the least WAI is preferred for a complimentary food. Samples containing 35 g soybean and 40 g soybean had significantly ($p<0.05$) higher water absorption index (WAI) than 45 g soybean containing sample. There was no significant difference ($p > 0.05$) on WAI between the main factor taro varieties but control samples had significantly higher WAI. When the lipid content is high in the flour, the water absorption index decreases because lipids block the polar sites of the proteins attenuating the absorption of water (Sathe and Salunkhe, 1981). The low WAI value (3.23) for 45 g soybean containing sample could be due to its high composition of fat than the reset samples.

Water Holding Capacity (WHC) of taro based complimentary food was ranges from 6.65 to 7.35. WHC refers to the ability of the protein to absorb water and retain it against gravitational force within a protein matrix (Foh *et al.*, 2010). Interactions of water with proteins are very important in food systems because of their effects on the flavor and texture of foods. On the other hand, functional properties of proteins in food system broadly depend on the water-protein interaction (Barbut, 1999). Water solubility index can be used as an indication of the degree of molecular damage (Colonna *et al.*, 1989). Commercial product had significantly higher WSI than all products. Starch has the tendency to become soluble after different cooking treatment and such phenomenon will contribute toward an increase in the WSI (Jones *et al.*, 2000). The increases were expected since high molecular weight carbohydrates and proteins were hydrolyzed to simpler more soluble components during the process (Achinewhu, 1986; Amadi *et al.*, 1999). There were insignificant difference ($P<0.05$) in water holding capacity and water solubility index among main factors blending ratio and taro variety. WHC of control samples were significantly ($p<0.05$) greater than that of the blended products.

3.4 Sensory Acceptability of Taro, Soybean and Carrot Based Gruel

The data on sensory evaluation on color acceptability of gruel from taro, soybean and carrot flours was ranged between 3.45 and 4.68 (between nether like nor dislike and like extremely). The result showed that there was significantly different ($P<0.05$) on color acceptability due to blending ratio and taro variety. Flavor and taste sensory acceptability of gruel were significantly ($p<0.05$) affected by interaction effect between taro variety and blending ratio. The highest score, 4.53 (between extremely like and like moderately) of flavor sensory acceptability was obtained for boloso-1 taro variety blended with 45 g soybean and this result was not significantly different from the score for boloso-1 taro blended with 40 g soybean (4.27) and local taro blended with 45 g soybean (4.25) (Table 4). The highest taste sensory acceptability value of gruel, 4.50 (between extremely like and like moderately) was scored for boloso-1 taro blended with 45 g soybean. The lowest value, 2.93 (between nether like nor dislike and dislike moderately) was obtained for boloso-1 taro blended with 35 g soybean (Table 15).

Interaction of blending ratio and taro variety had significant effect ($P<0.05$) on the overall sensory acceptability evaluation. The highest value (4.40) was scored for boloso-1 taro blended with 45 g soybean and the lowest value, 2.88 (between nether like nor dislike and dislike moderately) was scored for control sample of local taro variety. The overall acceptability evaluation scores of soybean fortified products received scores ranging from 3.12 to 4.40. This shows that overall acceptance level was above “neither like nor dislike” and below “extremely like”.

Table 1. Proximate Composition of Taro based Complementary Flours

Var*Br	Moisture (%)	Crude Protein (%)	Crude Fat (%)	Crude Fiber (%)	Ash (%)	Carbohydrate (%)	Energy (kcal)/100g
B-1*35 g	7.37±0.12^{b}	21.08±0.78^{e}	9.42±0.09^{b}	3.51±0.04^{d}	4.04±2.41^{f}	55.60±0.37^{d}	389.13±5.25^{b}
B-1*40 g	6.67±0.09^{de}	23.66±0.22^{c}	9.94±0.45^{a}	3.83±0.05^{cd}	4.24±0.01^{e}	53.39±1.79^{e}	394.48±7.08^{a}
B-1*45 g	6.29±0.22^{f}	24.60±0.39^{b}	10.14±0.09^{a}	5.29±0.05^{a}	4.50±0.03^{d}	51.57±0.28^{f}	396.07±0.64^{a}
L*35 g	6.90±0.17^{cd}	22.65±0.18^{d}	8.85±0.17^{c}	3.67±0.01^{cd}	4.92±0.01^{c}	53.12±0.31^{e}	382.67±2.09^{c}
L*40 g	6.53±0.33^{ef}	24.13±0.44^{bc}	9.48±0.07^{b}	3.97±0.02^{bc}	5.15±0.08^{b}	51.58±0.93^{f}	388.04±1.41^{b}
L*45 g	6.49±0.13^{ef}	25.99±0.14^{a}	10.15±0.05^{a}	4.28±0.08^{b}	5.32±0.33^{a}	49.70±0.15^{g}	393.82±0.47^{a}
Con... local	7.01±0.19^{c}	6.98±0.21^{g}	1.86±0.39^{e}	2.53±0.14^{e}	5.28±0.04^{a}	77.23±1.55^{b}	349.98±6.84^{d}
Con...B-1	7.68±0.08^{a}	6.62±0.00^{g}	1.63±0.40^{e}	2.29±0.27^{e}	4.04±0.08^{f}	77.75±0.69^{a}	352.08±0.86^{d}
Com..produc	3.45±0.03^{g}	17.94±0.66^{f}	4.73±0.15^{d}	0.80±0.16^{f}	2.99±0.00^{g}	70.08±0.38^{c}	394.69±0.60^{a}
Total mean	6.49	19.22	7.19	2.63	4.5	59.99	382.55
CV%	1.06	1.06	1.06	1.8	1.42	1.08	0.38

Table 2Mineral and anti-nutritional content of complimentary flour

Inter Var*BR	Fe (ppm)	Zn (ppm)	Ca (mg/100g)	Phenolic (mg/100g	Phytic acid (mg/100g)
B-1*35 g	87.94±1.80^{d}	90.62±0.63^{d}	24.25±0.36^{bc}	0.06±0.00^{c}	48.90±0.95^{cd}
B-1*40 g	93.11±1.01^{bcd}	94.84±0.95^{c}	25.47±0.16^{bc}	0.07±0.02^{abc}	52.32±0.40^{bc}
B-1*45 g	98.61±2.81^{ab}	97.64±2.38^{c}	26.26±1.11^{b}	0.08±0.00^{a}	57.87±1.01^{ab}
L*35 g	90.62±1.16^{cd}	87.55±0.67^{d}	22.25±0.64^{c}	0.02±0.01^{d}	47.33±0.91^{d}
L*40 g	96.59±1.16^{abc}	89.67±2.79^{d}	24.22±0.74^{bc}	0.06±0.00^{bc}	53.63±0.55^{ab}
L*45 g	102.21±1.40^{a}	96.19±3.41^{c}	25.26±0.99^{bc}	0.07±0.01^{ab}	56.65±0.94^{ab}
Con...local	74.79±6.84^{e}	103.89±0.44^{b}	24.51±0.85^{bc}	0.02±0.00^{d}	34.79±4.32^{e}
Con...B-1	69.78±5.31^{e}	109.66±0.58^{a}	26.75±1.79^{b}	0.02±0.00^{d}	33.13±1.64^{e}
Com..product	60.43±4.02^{f}	50.69±4.93^{e}	96.17±4.69^{a}	0.03±0.01^{d}	24.85±5.64^{f}
Total mean	86.00	89.85	32.79	0.05	45.50
CV%	0.12	2.66	0.35	6.22	0..28

Values are means ± standard deviation. Values followed by different letters within a column represents differences at 95% probability levels, Var*BR= interaction of variety and blending ratio; B-1*35g, B-1*40g and B-1*45g = interaction between B-1 and blending ratio of soybean(35g, 40g and 45g) in blended product, respectively; L*35g, L*40g and L*45g = interaction between L and blending ratio of soybean (35g, 40g and 45g) in complimentary flour. CV= coefficient of variance. Cont…local and Cont…B-1 = control samples of 100% local taro variety and 100 % boloso-1 taro variety, respectively. Com…produ= Cerifa(Commercial infant food popular in Ethiopia).

Table 2.Betacarotenen and functional properties complimentary f lour

Var*Br	Beta carotenen (mg/100g)	a_w	WAI	WHC	WSI%
B-1*35 g	1.65±0.02^{bcd}	0.54±0.01^{cd}	3.33±0.06^{d}	7.05±0.17^{bc}	12.79±0.18^{b}
B-1*40 g	1.70±0.03^{ab}	0.55±0.01^{bc}	3.36±0.05^{d}	6.95±0.18^{bc}	13.78±0.23^{b}
B-1*45 g	1.75±0.02^{a}	0.57±0.01^{a}	3.23±0.03^{d}	6.65±0.08^{c}	14.26±0.63^{b}
L*35 g	1.59±0.01^{d}	0.53±0.00^{e}	3.69±0.14^{c}	7.35±0.08^{b}	13.48±0.60^{b}
L*40 g	1.63±0.03^{cd}	0.54±0.01^{cd}	3.35±0.05^{d}	7.04±0.14^{bc}	13.75±0.32^{b}
L*45 g	1.68±0.08^{bc}	0.56±0.01^{b}	3.25±0.03^{d}	6.88±0.04^{bc}	14.25±0.72^{b}
Cont…local	0.24±0.01^{e}	0.48±0.00^{f}	4.21±0.09^{a}	9.23±0.46^{a}	13.03±0.61^{b}
Cont…B-1	0.28±0.04^{e}	0.53±0.01^{e}	4.00±0.04^{b}	8.87±0.45^{a}	12.01±1.07^{b}
Com…product	0.30±0.05^{e}	0.54±0.01d^{e}	4.33±0.18^{a}	7.22±0.62^{b}	16.99±3.89^{a}
Total mean	1.20	0.54	3.64	7.47	13.82
CV%	3.15	1.13	2.45	4.24	1.10

Table 3.Sensory Evaluation of Complementary Taro based gruel

VAR*BR	Color	Flavor	Taste	Over all acceptability
B-1*35 g	4.38±0.52^{a}	3.48±0.95^{c}	2.93±0.92^{e}	3.30±0.50^{e}
B-1*40 g	3.72±0.56^{c}	4.27±0.52^{ab}	3.78±0.69^{bc}	3.90±0.40^{bc}
B-1*45 g	3.62±0.69^{cd}	4.53±0.50^{a}	4.50±0.60^{a}	4.40±0.53^{a}
L*35 g	4.00±0.61^{b}	2.98±0.79^{d}	3.05±0.81^{de}	3.12±0.78^{ef}
L*40 g	3.73±0.73^{c}	3.57±0.89^{c}	3.87±0.57^{bc}	3.62±0.52^{d}
L*45 g	3.45±0.67^{d}	4.25±0.57^{ab}	4.38±0.72^{a}	3.73±0.61^{cd}
Con…local	4.18±0.62^{ab}	2.67±0.88^{e}	3.23±0.98^{d}	2.88±0.69^{f}
Con…B-1	4.43±0.67^{a}	3.27±1.27^{cd}	3.67±0.97^{c}	3.05±0.93^{f}
Com….product	3.37±0.97^{d}	4.05±1.05^{b}	4.07±0.76^{b}	4.12±0.42^{b}
CV %	17.66	22.56	21.67	17.36

Values are means ± standard deviation. A value followed by different letters within a column represents differences at 95% probability levels. Var*BR= interaction of variety and blending ratio; B-1*35g, B-1*40g and B-1*45g = interaction between B-1 and blending ratio of soybean (35g, 40g and 45g) in blended product respectively; L*35g, L*40g and L*45g = interaction between L and blending ratio of soybean(35g, 40g and 45g) in blended products respectively. a_W = water activity, WAI= water absorption index, WSI= water solubility index, CV= coefficient of variance. Cont...local and Cont…B-1 = control samples of 100% taro local variety and 100 % taro boloso-1 variety respectively. Com …prod= Cerifam (Commercial infant food popular in Ethiopia

4. Conclusions

The study showed that fortification of complimentary food with properly treated soybean like blanched, soaked and roasted, is suitable for improving the low protein containing food like taro to improve the nutritional value. Boloso-1 taro variety had contributed significantly higher flavor and overall sensory acceptability than local taro variety in the infant complimentary food. The results showed good indicators of the possibility for better utilization of local household foodstuff to formulate infant complementary foods. This will ensure availability and affordability as well as help in alleviating some economic problems that will cause malnutrition, mortality and morbidity in infants in the developing country. Finally, at present the cost of commercial infant foods are very high in Ethiopia and it shows no sign of a price decline. Thus it is believed that this study could give impetus for further research into the use of composite flour in general and taro-soybean-carrot flour blends in particular for making complementary foods. Generally the present result suggests that blending 45 g soybean with boloso-1 taro variety was found to have better nutritional content, reduced anti-nutritional level and better sensory acceptability.

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