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Optimization and Evaluation of Finger Millet-common Bean Flour Blending for Better Nutritional and Sensory Acceptability of Porridge

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Abstract: This study was conducted to evaluate the nutritional quality and sensory acceptability of porridge formulated from different proportions of finger millet (F. M.) and common bean (C. B.) composite flours. The objective of the study was to enhance nutritional quality of porridge by incorporating common bean flour in finger millet, and thus to enhance beans utilization in Ethiopia. The art of food formulation is currently the best way to complement the nutritional contents of cereals and legumes, and widely applied in developing countries. Functional properties and proximate compositions of the composite flours were characterized following AOAC method and Abiodun and Kusumayanti methods respectively. Five different porridges were prepared from different proportions of the flours using mixture design (50%F. M: 50%C. B, 62.5%F. M: 37.5%C. B, 100%F. M, 87.5F. M%: 12.5C. B and 75%F. M: 25%C. B), and sensory properties like colour, mouth-feel, aroma taste and overall acceptability of porridges were evaluated using a 5-point Hedonic scales. Proximate compositions result was ranged from 7.90-9.091% (moisture), 10.21-14.486% (protein), 1.52-7.48% (crude fiber), 2.208-3.449% (ash), 65.271-76.38% (carbohydrate) and 330.95-356.610 Kcal/100g (calorie/energy value). The result of functional properties was ranged from 0.725-0.921g/mg, 117.50-155.10g/g, 120.36-145.83g/g, 6.038-14.530% and 65.167-77.33% for bulk density, water absorption capacity, swelling power, water solubility index and despersibility respectively. The composite flours were also found to have mineral contents of (2136.5-3118.1, 2904.5-6926.8, 1822.2-5548.6, 112.57-156.18, 250.1-449.099 and 21.31-24.54) mg/kg for Ca, K, P, S, Fe and Zn respectively. The result of sensory showed that the porridges were evaluated for appearance or colour, aroma, taste, mouth-feel and overall acceptability were found to have 3.57-3.38, 3.29-3.97, 3.12-3.48, 3.49-3.80 and 3.38-4.17 for respective attributes. It was observed that the difference between the treatments (formulations) was not significant (P>0.05) for other sensory attributes except, aroma and overall acceptability of the porridge. However, the nutritional and functional properties of the composite flours showed significant differences among the treatments. In general, it was concluded that 50%FM to 50%CB ratios resulted in the highest protein content of the composite flour whereas the porridge with acceptable quality could be prepared from composite flours of 87.5% F. M and 12.5% C. B.

Keywords: Functional Properties, Proximate Composition, Sensory Evaluation, Common Bean, Porridge, Finger Millet

1. Introduction

Malnutrition among children is a significant public health problem in developing countries, including Ethiopia [1]. The problem of protein-energy malnutrition among children is very common in developing countries, mainly because of relying only on cereal-based diets. In a society with a low-income level, it is challenging to live on animal-based protein sources like milk and meats, as well as poultry products like eggs due to their unaffordable price. Traditionally made cereal–legume blends have a better nutritional profile than solely cereal-based complementary food [2]. The protein-rich and high energy food formulations based on cereal legume mixtures at an affordable price have been recommended for poor rural societies [3]. The complimentary food strategies to boost the nutritional composition of diet are in practice in many countries, including Eastern Africa [4]. In line with this, Common bean (*Phaseolus vulgaris* L.) as one of the protein-rich legume crops is the world's most important food legume for direct human consumption to be mixed with cereals to formulate nutritious diets. The common bean is one of the essential legumes worldwide [5], and is an essential source of protein in Eastern Africa and Latin America [6], and a good source of micronutrients like Iron, zinc, thiamin and folic acid [7]. The beans are a good source of proteins which is more than two times that of cereal grains [4].

On the other hand finger millet (*Eleusinecoracana*) is a good source of nutrients especially of Iron, magnesium, calcium and other minerals and fibre, and gained importance because of its functional components, such as slowly digestible and resistant starch [8]. Finger millet is vital because of its excellent storage properties and nutritive value [9], and an important staple food for people in the low socio-economic group and those suffering from metabolic disorders like diabetes and obesity. Ethiopia is a producer of finger millet and use as a staple food in different parts of the country [10]. Finger millet grain is nutritious and versatile which can be cooked other cereals, ground to make porridge or flour [11]. Fortification of plant-based complementary foods can be an effective strategy for addressing childhood malnutrition in developing countries [12], provided that it is affordable for most of the population. Fortification of traditional cereal-based meals with protein-rich legumes has been identified as a possible means of alleviating protein-energy malnutrition (PEM) among low-income populations [13]. The flour of finger millet is utilized for the preparation of various food products like porridge and bread [10]. Processing finger millet using traditional as well as modern techniques for the development of value-added and acceptable food products would be the possible solution for its promotion and enhancement of consumption. Despite high production and productivity potential of beans, their consumption and potential role in food product development or in food formulation has not been well exploited in Ethiopia.

The art of formulation in Food technology enables us to complement cereal protein with legumes to get nutritious and cheaper sources of protein as compared to animal based protein, enhance consumptions of beans and boost the nutritional value of the product. Hence, incorporation the beans in Ethiopian diets through the technologies of blending common bean with finger millet flour got attention to increase the nutritional composition of the composite food product and enhance the utilization of both crops in the country. The developed finger millet and common bean flour based porridge is an important input for consumers to combat malnutrition in Ethiopia. Therefore, the objective of this study was to develop a finger millet-based food product fortified with common bean flour and to evaluate the sensory and nutritional content of porridge made up of the composite flours.

2. Materials and Methods

2.1. Sample Collection and Preparation

Common bean (*Phaseolus Vulgaris*) variety (Roba), and finger millet (*Eleusinecoracana L.*), variety Tadesse, were collected from Melkasa Agricultural Research Centre, Ethiopia. Common beans were manually cleaned by handpicking the chaff and stones. The cleaned beans were washed with water in order to remove the adhering dirt. The beans were soaked in water for about 10 minutes and pounded gently in a mortar to dehull, then dried and milled. Finger millet grain was sorted, roasted and milled by Cyclone sample mill (Model: 3010-019) to obtain flour at Melkasa Food Science and Post-Harvest Technology Laboratory.

2.2. Formulations of Composite Flours

Composite flour of finger millet (F. M.) and common bean (C. B.) was prepared, as shown in Table 1. Hundred percent (100%) finger millet flour was used as a control and represented as Run_3. The composite flours composed of 50%FM: 50%CB, 62.5%FM: 37.5%CB, 87.5%FM: 12.5CB and 75%FM: 25%CB flours were represented by Run_1, Run_2, $Run_4$and Run_5respectively.

Table 1. *Formulations of finger millet with common bean flours.*

Ingredients	Run_1	Run_2	Run_3	Run_4	Run_5
Finger millet flour (g)	50.00	62.50	100	87.50	75.00
Common Bean (g)	50.00	37.50	0.00	12.50	25.00
Water (L)	0.75	0.75	0.75	0.75	0.75
Salt (teaspoon)	1.00	1.00	1.00	1.00	1.00

2.3. Porridge Preparation

A thick and consistent porridge was made from the finger millet-common bean formulations by cooking with warm water and stirring until the desired consistency was attained**.** Porridge made up of hundred percent (Run_3) finger millet flour was used as a control. The porridge was kept until it got cooled to a mild temperature to serve to panelists with plastic plates.

2.4. Sensory Evaluation of the Porridges

Each porridge sample was evaluated by a semi-trained panelists of 25 people briefed about scoring a sensory attribute using a 5-point hedonic scales representing 5-like very much, 4-like, 3-neither like nor a dislike, 2-dislike and 1-dislike very much. The sensory attributes used for evaluation were appearance/colour, aroma, taste, mouth-feel, and overall acceptability.

2.5. Functional Properties

Bulk density, Water Absorption Capacity, Dispersibility of the composite flours were determined using standard methods [14]. Solubility and swelling power were determined following the methods of Kainuma and Leach, as cited by Kusumayanti [15].

2.6. Composition Study

The proximate composition including moisture (AOAC 925.10), ash (AOAC 923.03), fat (AOAC 945.16), fibre, and protein content of both the composites flours and porridge were determined following AOAC methods. Carbohydrate content was determined by the difference method. The mineral content of the flour was also determined using standard procedure [16].

2.7. Statistical Analysis

Triplicate samples were considered for proximate composition, functional properties and sensory evaluation. The data obtained was, then, subjected to analysis of variance (ANOVA) and analyzed using Statistics 10.0 and the least significant difference (LSD test) was employed to separate the means.

3. Result and Discussions

3.1. Proximate Composition Composite Flours

The results of statistical analysis showed that the mean proximate values of the composite flours were significantly different at ($P \leq 0.05$) except in the case of protein. The proximate compositions values of the composite flours ranged between 7.9873- 9.091% moisture, 2.2083-3.4497% ash, 8.8430- 14.4860% protein, 1.0603-1.5167% crude fat, 1.5190-7.4817% crude fibre and 68.720-79.2290% carbohydrates and 330.950-356.610 Kcal/g (Table 2). In this study, it was found that the moisture content of the composites was less than 12%. The low moisture content of these formulations is a good indicator of the potential of the composites to have a longer shelf life. It is believed that materials, such as flour and starch, containing more than 12% moisture content have less storage stability than those with lower moisture content [17].

On the other hand, Run_1 (50%FM: 50%CB) had the highest ash value (3.4497%), and control sample (100% F. M.) had 2.2083%. High ash value of food samples is an indication of high mineral content [18]. Hence, the high ash value of the flour sample Run_1 may likely be due to the substitution of finger millet with 50% common bean flour since it is rich in K and P contents. The ash content obtained in this study is more significant than which obtained by Gull [19] for finger millet (2.20%). The study showed that the ash content of the flour samples increased with increasing substitution of finger millet flour with common bean flour (Table 2).

Concerning protein content, the composite flours had values ranging from 10.215-14.480%. The control sample (100% F. M.) had the lowest protein content (8.8430%) while the sample Run_1 (50%FM: 50%CB) ranked first (14.486%), followed by Run_2 (62.5%FM: 37.5%CB) 13.1140%. The protein content result reported by Khetarpaul [20], on porridge prepared from soy-sorghum grits composite was in the range of 9.64-14.91%, which is in agreement with the present study. The Run_5 (75%FM: 25%CB) was the least of all the formulations in moisture (7.9040%) and crude fibre (1.5190%) contents, but it ranked first in carbohydrate content (76.34%) (Table 2). In general, the carbohydrate content of the composite flours increased with decreasing proportion of common bean. This showed that the addition of common bean flour contributed less to the carbohydrate content of the composites.

The crude fibre content of the composite flours was in the range of 1.52 to 7.482% (Table 2). Though most of the samples had statistically similar values, sample Run_1 (50FM: 50CB% flour) significantly differed from rest of the samples in crude fibre content and exhibited the highest value (7.4817%). According to Saleh et al., [21], the fibre content of finger millet was reported to be 3.6% which is lower than fibre content (4.049%) of the control sample (100% finger millet) in this study. However, the present study revealed that high fibre content for fifty percent substitution of finger millet flour with common bean flour. This could be due to the richness of both finger millet, and common beans are rich in fibre. The Cade et al. [22], stated that high fibre content of millet contributes to its hypoglycemic, and helpful to patients with constipation.

Table 2. *Nutritional composition of finger millet-common bean composite flours.*

Treatments	Nutritional compositions						
	Moisture%	**Protein (%)**	**Crude fibre%**	**Fat (%)**	**Ash (%)**	**CH_2O (%)**	**Energy Kcal/100g**
Run1	7.987±0.185^{b}	14.486±0.18^{a}	7.482±1.926^{a}	1.325±0.02^{b}	3.449±0.065^{a}	65.271±2.189^{c}	330.95^{c}
Run2	9.069±0.364^{a}	13.114±0.23^{b}	4.317±1.778^{b}	1.175±0.025^{b}	3.091±0.029^{b}	69.234±2.175^{b}	339.96^{ab}
Run3	9.091±0.363^{a}	8.843±0.192^{e}	4.049±1.815^{b}	1.5167±0.052^{a}	2.208±0.079^{e}	740.292±2.374^{a}	346.19^{ab}
Run4	8.944±0.302^{a}	11.729±0.0708^{c}	2.520±1.397^{b}	1.060±1.397^{d}	2.442±0.029^{d}	73.298±1.164^{a}	349.71^{ab}
Run 5	7.90±0.11^{b}	10.21±0.32^{d}	1.52±1.420^{b}	1.13±0.030^{c}	2.840±0.010^{c}	76.380±1.490^{a}	356.610^{a}
Mean	8.599	11.677	3.977	1.243	2.806	71.697	344.680
CV	*3.310*	*1.870*	*42.300*	*2.84*	*1.78*	*2.70*	*2.190*
LSD@5%	*0.517*	*0.396*	*3.061*	*0.064*	*0.091*	*3.52*	*13.71*

** Means followed by the same letters in the same column are not significantly different @ 5% probability level FM-Finger Millet CB: Common Bean. CHO: Carbohydrate. All values are a mean of triplicates. $Run_{1-50\%FM:50\%CB}$ $Run_{2-62.5\%FM:37.5CB}$ $Run_{3-100\%FM:0\%CB}$ $Run_{4-87.5\%FM:12.5\%CB}$ and $Run_{5-75\%FM:25\%CB}$

It was observed that sample Run_1, and Run_2had almost similar values of fat contents where as Run_3.(100%FM) had the highest fat content (1.5167%), and followed by Run_1 (50FM: 50%CB) with (1.325%). The crude fat content in finger millet has been reported to be in the range of 1.3 to 1.8% [23]. Hence, the present study showed that fat content of finger millet was not affected by the substitution of finger millet flour with 50% common bean flours. In general, fibre (4.043%), protein (8.843%) and carbohydrate (74.292%) contents of the control sample in the present study are high as compared to result reported for finger millet [19]. The caloric value of composite was significantly different ($P<0.05$) among the treatments. The highest and lowest energy content was observed for Run_5 and Run_1 with respective mean caloric values of 356.61 Kcal/100g and 330.95 Kcal/100g.

3.2. Functional Properties of the Composites Flours

Functional properties of the formulations were significantly different ($p<0.05$) for treatments. Bulk density, water absorption capacity, swelling power, water solubility and dispensability values ranged from 0.75-0.9207g/mg, 117.5-145.102g/g, 120.360-145.830g/g, 6.0383-14.530% and 65.167-77.333%, respectively. Bulk density is a measure of the heaviness of flour and is generally affected by the particle size and the density of the flour. Bulk density of Run_1 was the highest (0.9207g/ml) followed by Run_2 andRun_5 with mean values of 0.8247g/ml and 0.8200g/ml. The increase in bulk density of composite flours is likely due to the substitution of finger millet flour by common bean flour (Table 3). According to [24], it was stated that high bulk density is a desirable characteristic for the packaging of food with high nutrient contents. In the present study both the highest (0.9207 g/ml) and lowest bulk density (0.725g/ml) obtained are greater than the result reported by Gull *et al*., [19], 0.67g/ml and 0.55g/ml for finger millet and pearl millet flour respectively. The change in bulk density is generally affected by particle size and density of the flour, and it is vital in determining packaging requirement and material handling [25]. Water solubility Index (WSI) determines the number of free polysaccharides or polysaccharide released from the granule after addition of excess water [26]. Water Solubility (WSI of finger millet and common bean composite flour was significantly affected by the treatments. It increased with an increasing level of common bean flour, but not in a regular way. The composite flour Run1 (50%FM: 50CB%) was found to have high Water solubility index (14.530%) followed by Run_5 and Run_2 with mean values 11.3170, 11.047% respectively. The lowest value of the WSI of the control sample (Run3) could be because of the high content of starch, low contents of protein and fat in finger millet. According to Wang, it was reported that the amount of protein and fat could inhibit starch granules swelling [27].

The swelling power of the composite flours ranged from 120.36-145.83g/g. Sample Run_2 (67.5%FM: 37.5%CB) was significantly ($P\leq 0.05$) different from the other treatments and had a maximum swelling power. (Table 3). The variation in the swelling capacity indicates the degree of exposure of the internal structure of the starch present in the flour to the action of water [28]. In line with this, it has been reported that swelling power is regarded as a quality criterion in some food formulations such as bakery products and it is an indication of the presence of amylase which influences the quantity of amylose and amylopectin present in the flour. The higher the swelling power, the higher the associate forces. The current result of swelling power is by far higher than the value (5.15-5.69g/g) reported for pearl millet-Kidney beans-Tiger nut composite flour [29]. This higher swelling power could be due to the starch present in composite flours was easily hydrated. Food eating quality is often connected with the retention of water in the swollen starch granules [30].

Table 3. *Functional properties of the composites flours.*

Treatments	Functional Properties				
	Bulk density g/mg	**Water Absorption Capacity g/g**	**Swelling power g/g**	**Water solubility Index%**	**Despersability (%)**
Run1	0.921±0.03^a	144.530±7.35^a	144.84±6.36^a	14.530±0.75^a	65.167±0.29^e
Run2	0.823±0.03^b	145.100±17.98^a	145.83±3.71^a	11.047±0.20^b	66.500±0.50^d
Run3	0.725±0.02^d	117.50±15.95^b	120.36±0.59^c	6.038±0.60^d	77.333±0.29^a
Run4	0.778±0.03^c	137.300±4.004^{ab}	136.990±4.28^b	7.981±0.25^c	73.833±0.29^b
Run 5	0.82±0.02^c	139.07±1.81^a	137.21±1.10^b	11.31±1.49^b	68.500±0.50^c
Mean	0.81	136.70	137.05	10.183	70.267
CV	3.00	8.35	2.81	7.92	0.55
LSD@5%	0.04	20.76	7.01	1.47	0.70

** Means followed by the same letters in the same column are not significantly different @ 5% probability level FM-Finger Millet CB: Common Bean. All values are a mean of triplicates. $Run_{1-50\%FM:50\%CB}$ $Run_{2-62.5\%FM:37.5CB}$ $Run_{3-100\%FM:0\%CB}$ $Run_{4-87.5\%FM:12.5\%CB}$ and $Run_{5-75\%FM:25\%CB}$

The water absorption capacity (WAC) measures the volume occupied by the starch after swelling in excess water, which maintains the integrity of starch in aqueous dispersion. It is the water retained by a food product following filtration and application of mild pressure of centrifugation [30]. Results of the present study showed that the highest WAC was observed for Run_2 (145.10g/g) and the lowest value for Run_3 (Control) (117.50g/g). This result is quite higher than the result for reported for beans flour (123.4 to 138.0%) [31]. It was reported by [30] that the WAC values of cocoyam flours were within the range of 32-69% which is by far lower than the current result. The WAC values obtained in the current study are higher than in other studies. This shows that the flours with such characteristics can be used in the preparation of thickened products like porridge. Despersibility value of the composites showed that the control sample had the highest value which was 77.333% and followed by $Run_4$and $Run_5$with the values of 73.833% and 68.5% respectively. The result reported by [29] showed that the dispersibility value of finger millet-kidney beans-tiger nut flour was in the range of 71.00-80.0% which is not in agree with the result obtained in this study.

3.3. Mineral Content of Composite Flours

Mineral contents of composite flours of finger millet and common bean, including the control sample are presented in Table 4. It was observed that mineral content of the composite flours ranged from 1809.3-3118.1mg/kg, 2904.5-6926.8mg/kg, 1822-5548mg/kg, 250.10-449.99mg/kg, 21.314-24.542mg/kg and 112.57-156.18mg/kg for Ca, K, P, Fe, Zn and S respectively (Table 4). Sample Run1 (50FM: 50%CB) had higher K, S, and P contents than the control sample (100%FM flour) which exhibited higher values of Fe, Na, Ca and Zn followed by Run_4 (87.5FM: 12.5%CB) with (400.1mg/kg) Fe and (23.735mg/kg) Zn. The Fe and Zn content of millet-based composite flours (cowpea leaves, pumpkin seeds, carrots, and skimmed milk powder) was reported by [32] as 3.6 and 4.2mg/100g, respectively. This is lower than the result of Fe and Zn in the present study. The addition of common bean has contributed less to other minerals in the flour except for K, P and S, which increased with an increase in the proportion of common bean flour in the composites. The previous study on the mineral content of finger millet was reported as 70.89, 0.74, 0.45 and 60.80 mg/100 for Ca, Fe, Zn, P [33], which is by far lower than the result of the current study.

Table 4. *Mineral content of Finger millet-Common bean composite flours.*

Treatments	Minerals (mg/kg)					
	Ca	**K**	**P**	**S**	**Fe**	**Zn**
Run1	1809.3±9.20[e]	6926.8±30.84[a]	5548.6±2.35[a]	156.18±0.81[a]	250.10±1.02[e]	21.314±0.12[e]
Run2	2136.5±11.0[d]	5921.2±23.35[b]	2550.2±6.33[b]	145.28±0.86[b]	300.07±1.31[d]	22.121±0.12[d]
Run3	3118.1±17.81[a]	2904.5±5.78[e]	1822.2±8.80[b]	112.57±1.45[e]	449.99±2.22[a]	24.542±0.15[a]
Run4	2790.9±15.6[b]	3910.1±9.29[d]	2064.9±5.58[b]	123.47±1.21[d]	400.10±1.91[b]	23.735±0.14[b]
Run 5	2463.7±13.[c]	4915.6±16.02[c]	2307.5±4.32[b]	134.37±1.01[c]	350.04±1.61[c]	22.928±0.14[c]
Grand mean	2463.7	4915.6	2858.70	134.37	350.04	22.928
CV	0.56	0.39	37.32	0.82	0.48	0.62
LSD@5%	25.11	35.21	19.40	1.99	3.04	0.26

** Means followed by the same letters within a column are not significantly different at 5% probability level. All values are mean of triplicates. $Run_{1\text{-}50\%FM: 50\%CB}$, $Run_{2\text{-}62.5\%FM: 37.5CB}$, $Run_{3\text{-}100\%FM: 0\%CB}$, $Run_{4\text{-}87.5\%FM: 12.5\%CB}$ and $Run_{5\text{-}75\%FM: 25\%CB}$

3.4. Sensory Attributes of the Porridge

Sensorial properties of porridges made from the different composite flours are shown in Figure 1. Results of the sensory Analysis showed that there was no significant difference (p≥0.05) between treatments for sensory attributes except for aroma and overall acceptability. With regard to appearance, Run_3 (100%FM) had the highest value, (3.8153 and followed by Run_4 (3.7320), Run_1 and (3.7083) while Run_2 (3.5597) exhibited the lowest value. Similarly, porridge sample Run_3 (100%FM) had the highest aroma value (3.9763) and followed by Run_4 (87.5FM: 12.5%CB) with a value of 3.9107 while Run_2 had the lowest value (3.2917). In terms of taste, porridge sample Run_4 had the highest value (4.820) and Run_1 (50FM: 50%CB) had the lowest mean value, (3.1250). The lowest score value of taste could be attributed to the more enhanced beany flavour at higher proportions of the common bean flour in the composites. It was reported by [34] showed that the sensory attributes of yam-cowpea-soybean porridge were found to be 3.3-4.8, 3.3-4.5, 2.8-4.8 and 3.3-6.8 for colour, aroma, taste and overall acceptability which is higher than the current result.

The control sample had the highest mouth-feel value (3.8097), followed by Run_3had the value (3.6727) Run_1 had the lowest value (3.4940). Overall acceptability of the porridge samples was significantly affected by the supplementation of common flour, where Run_4 (87.5FM: 12.5%CB) had the highest value (4.1787) followed by control Run_3 (3.9107), while Run_2 had the lowest value (3.3810) (Figure 1). The study conducted by [35] stated that sensory attribute result of porridge prepared from blends of 24-hour fermented wateryam (W. Y.), cocoyam (C. Y.), plantain (P. T.), African yam- bean (AYB), cowpea (C. P.), pigeon pea (P. P.) and corn (C) flour in different proportions was found to be in the range of 6.12-8.60, 5.46-8.40, 5.50-7.60, 5.10-8.70 for colour, flavour, texture and general acceptability which is higher than the result of the current study. The result of the present study revealed that the porridge sample composed of 87.5%FM and 12.5%CB was rated by the panelists as highly acceptable probably because of its superior taste, while Run2 (67.5FM and 32.5CB ranked as least (3.3810). The control sample Run3 (100%FM) also ranked better than other treatments, probably due to its higher appearance, aroma and mouth-feel values. Comparatively, lower score values of sensorial properties for porridge sample Run2 (67.5FM: 37.5CB) might have contributed to its least overall acceptability. In general, the sensory analysis showed that the panelists appreciated porridge prepare from composite flours in the order of Run_4 (87.5FM: 12.5%CB), Run_1 (50FM: 50CB%), Run_5 (75FM: 25%CB) and Run2 as (62.5FM: 37.5%CB) as compared to the control.

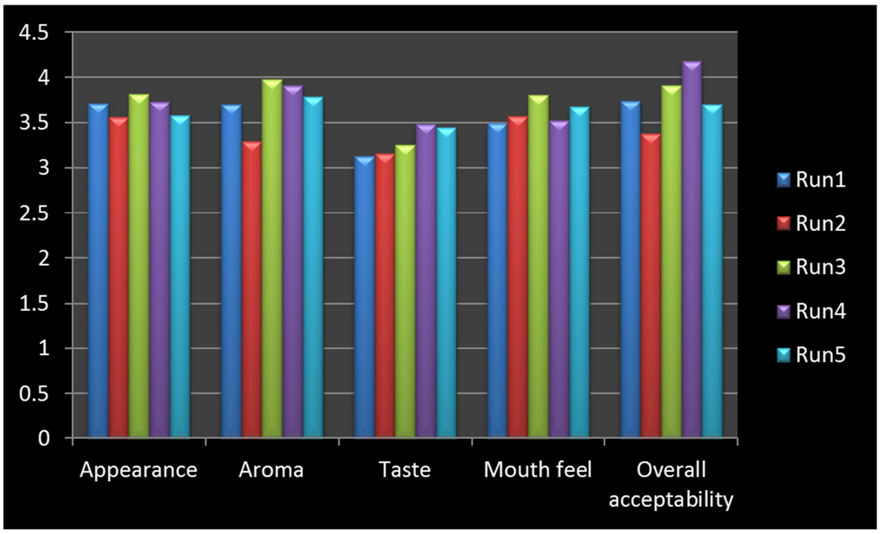

Figure 1. *Sensory data of porridge.*

*Means with the same letters are not significantly different. FM-Finger Millet CB: Common Bean. All values are mean of triplicates ± Standard deviation. $Run_{1\text{-}50\%FM:50\%CB}$ $Run_{2\text{-}62.5\%FM:37.5CB}$ $Run_{3\text{-}100\%FM:0\%CB}$ $Run_{4\text{-}87.5\%FM:12.5\%CB}$ and $Run_{5\text{-}75\%FM:25\%CB}$

4. Conclusions

It was observed that composite flour with the highest protein content was achieved by blending 50%Finger millet: 50% Common bean. Porridge of acceptable quality was prepared from composite flours of 87.5% finger millet and 12.5% Common bean. Therefore, it was concluded that the use of the common bean in combination with finger millet in appropriate proportions could enhance the utilization of both cops and alleviate the problem of protein malnutrition by avoiding relying on a single crop. This art of formulation can alleviate the problem of malnutrition in developing countries. The poor rural societies of developing countries and Ethiopia, in particular, can apply this result in their diet. The research Institute should train the concerned stakeholders to help the farmers practice the art of food formulations to improve the nutritional quality of the diet. The training plays a vital role to give knowledge and skills to the consumers.

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