

Development of Porridge from Kocho and Chickpea Composite Flours: Evaluation of Nutritional Composition and Functional Properties of the Flours and Sensory Properties of the Porridge

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Abstract

The main objective of this study was to develop porridge from Kocho and Chickpea composite flour: and evaluate the nutritional and functional properties of composite flours and sensory property of the porridge to improving nutritional contents of developed porridge. Proximate and mineral compositions, functional properties of flour products and sensory acceptability of the porridge were analyzed using standard methods. A preliminary experiment was done by soaking and germination of chickpea to improve acceptability and nutritional contents of the porridge. Based on the preliminary results, the experiment was done by preparing seven formulations of the composite flours. The formulated flours porridges were prepared in a such a way that ratio of Kocho: Chickpea in percent (100:0.0 (control), 70:30 un-soaked chickpea, 70:30 soaked chickpea, 70:30 germinated chickpea, 60:40 unsoaked chickpea, 60:40 soaked chickpea and 60:40% germinated chickpea). The porridge prepared from blending of chickpea 30% and 40% with kocho flour observed significantly highest value in proximate composition, mineral content and functional properties ($p < 0.05$). Porridge prepared from T₃ (70%:30%) and T₆ (60%:40%) which means Kocho with germinated chickpea flour next to soaked chickpea flour products accepted by most panelists for sensory attributes and it was significantly different from the control. The proximate composition revealed that as the proportion of germinated chickpea flour increased, the protein content of the porridge is increased. Protein-energy malnutrition which affects children in case of eating protein low food Kocho, can be minimized by blending chickpea flour when porridge preparation. The product prepared from 70% of kocho and 30% unsoaked chickpea flour had the lowest bulk density content. Whereas the product prepared from 70% of kocho and 30% germinated chickpea flour was observed highest in oil absorption capacity content The product prepared from 60% of kocho and 40% germinated chickpea flour had highest water absorption capacity. The porridge prepared from 70% of kocho and 30% unsoaked chickpea flour seen highest viscosity score. The product which prepared from 70% of kocho and 30% germinated chickpea flour was observed highest for calcium and magnesium content. While the zinc content of the product prepared from 100% of Kocho/control was significantly higher than other developed products. Therefore, blending chickpea flour with kocho can minimize the high contents of zinc. The porridge which prepared from 60% of kocho and 40% germinated chickpea flour had the highest mean score appearance and accepted by most panelists. For the color score, the porridge prepared from 60% of kocho and 40% germinated chickpea flour observed the highest score and preferred by most panelists.

Keywords: Kocho; Chickpea; Soaking; Germination; Composite flour; Porridge

Introduction

Malnutrition affects about 170 million people especially preschool children and nursing mothers of developing countries in Asia and Africa [1]. Child malnutrition affects physical growth, morbidity, mortality, cognitive development, reproduction, and physical work capacity [2,3]. Children malnutrition in Ethiopia constitutes big challenges as the country had 17% under-five mortality rates in 2001 of which an estimated 57% was severe and mild to moderate malnutrition by Alemu et al. [4]. The severe clinical forms of Protein-Energy Malnutrition (PEM) include Marasmus, Kwashiorkor and Mixed feature called Marasmic-kwashiorkor [5]. Prevalence of stunting in fewer than five aged Ethiopian children is forty-four percent; of which twenty-one percent is severely stunted whereas twenty-nine percent of children are underweight and wasting affected ten percent of children with same age group [6]. In this SNNP the prevalence of stunting is (44.1%), underweight (28.3%) and wasting (7.6%). Lack of food, improper infant and child feeding practices critically affects child growth, development, and survival when coupled with high rates of infections during the first two years of life [7].

The complimentary period is the most critical period in a child's life as an infant's transfer from nutritious and uncontaminated breast milk to the regular family diet with a chance of vulnerable to malnutrition

and disease. Complimentary food is normally a semi-solid food that is used in addition to breast milk and not to replace it and started at the age of six months. In SNNP, complementary foods are usually made of cereals/root crops may be low in both macro and micronutrients like protein, vitamin A, Zinc, Magnesium Iron and others [8,9]. Porridge is non-drinkable food made by food industry or family. When infants start taking solid foods or porridges the term weaning is often used furthermore, weaning usually indicates a transition period or process from breast-milk or infant formula to porridge [10]. According to UNICEF and WHO [11], introducing solid foods into an infant's diet is recommended at about six months because at that age breast milk is no longer adequate in meeting a child's nutritional needs to promote

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Received December 26, 2018; **Accepted** February 05, 2019; **Published** February 09, 2019

Citation: Haile A, Shufa T (2019) Development of Porridge from Kocho and Chickpea Composite Flours: Evaluation of Nutritional Composition and Functional Properties of the Flours and Sensory Properties of the Porridge. J Food Process Technol 10: 788. doi: [10.4172/2157-7110.1000788](https://doi.org/10.4172/2157-7110.1000788)

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optimal growth. According to Recommended Dietary Allowance (RDA), children which aged 1-3 years food is 1554 kJ/100 gm (minimum of energy), protein 10.9 gm/100 gm, 2/3 of the daily requirement for minerals and vitamins 4.21 mg of iron/100 gm and 270 µg of vitamin A/100 gm respectively [12,13].

Food and nutrition security is a major global concern, especially in developing countries. Currently, many countries in sub-Saharan Africa depend on a narrow base of food because there are situation minimizes variety in food production that lead to insecurity in food and poor nutrition. Most rural people food processing pattern depended on energy-rich trends especially Enset and cereals (Maize) for a long period of time. Foods which mean Kocho, Bulla, and Amicho produced from Enset plants are low in protein content. Considering the low nutrition value of kocho therefore, searching for superior nutritional quality and yield that have domestication potential such as chickpea crop which is presently a highly rich legume. The prevalence of malnutrition among different age groups particularly children under 5 years in Ethiopia constitutes a particularly daunting challenge as the country had which an estimated 57% was linked to severe and mild to moderate malnutrition [4].

Commercial infant foods are very expensive and out of reach of low-income families in developing countries [14]. Products such as Edget, Cerefam, barley mix, Famix, and Favena are infant food available in the country. But these foods may not be available to most low-income households. Infant foods in many parts of Ethiopia are cereal or root crop-based because these are major components of the family's diet. So it is important to begin to explore the possibility of locally available food in complementary food formulation. Inadequate macro and micronutrients in food is a major cause of the high incidence of child malnutrition, morbidity, and mortality [15]. In Ethiopia, infant foods are rarely modified at the household level to increase nutrient density to meet the needs of infants. Traditional infant foods made of cereals (wheat, barley, and others) or tubers (Enset, potatoes, and others) are low in several nutrients including protein, vitamin A, zinc and iron reported by Abebe et al. [8]. Furthermore, the bulkiness of traditional complementary foods with high concentrations of fiber and anti-nutritional factors are major factors that reduce nutritional benefits. Ideally, complementary foods should contain animal source foods with high biological value to foster growth and development. However, these foods are not available or affordable for most low-income households. To improve the bulkiness of the complementary foods and to suppress the anti-nutritional contents using different processing like soaking, germination and fermentation can be used. Therefore, this study aims to develop porridge from kocho and chickpea composite flours and evaluation of the nutritional and functional properties of the composite flours and sensory property of the porridges.

Materials and Methods

Raw material collection and preparation

Kocho (*Enset ventricosum* (Welw.) Cheesman) "Addo" (Vernacular name) popular variety of Enset in Sidama was prepared at SNNP, Sidama Zone Hawassa City administration Tulla sub City Haranfama kebele and Chickpea (*Cicer arietinum* L.) "Natoli" type (Desi variety) were purchased from Debrezeit Agricultural Research Center (Oromia region). Sample preparation and analysis was done at a Laboratory of School of Nutrition, Food Science and Technology, College of Agriculture, Hawassa University.

Experimental design and formulation of composite flours

The experiment was made in one factor (7 levels) which had three processed flours (unsoaked, soaked and germinated chickpea flour) and two blending ratio (70%) and (60%) of kocho flours were considered in the experiment to develop a porridge considering the useful food processing tools. Porridge and product prepared from 100% Kocho flour was taken as a control.

Kocho flour preparation

Kocho flour was prepared according to the method used by Abebe et al. [8]. Raw kocho from "Addo" Enset plant was pulverized and stored for three weeks to ferment. Then the fermented kocho was manually homogenized (mixed), squeezed and dried by Enset fiber for flour process (Figure 1). The dried kocho flour was passed through a household sieve to reduce fiber.

Chickpea flour processing

Soaking: For soaking tests, 6 kg of the chickpea sample was weighted in three parts into the plastic container, and filled to the mark with tap water. Chickpeas were cleaned, graded, sorted and washed three times using tap water. Then, the chickpea was soaked separately in tap water for 24 hours at a temperature of 23°C with chickpea to water ratio of 1:3 (w/v) [16]. Chickpeas were soaked into three plastic containers (water bath). Each of plastic (water bath) the soaked chickpeas containing 6000 ml water and left for 25 min at a temperature of 23°C for surface disinfection. Some broken and floating chickpeas were removed at this stage and separated from the rest of the chickpeas. The hydrated chickpeas were then removed and washed three times in water for 25 min and soaked in tap water separately [17]. The unimpeded water was discarded and the soaked chickpeas were twice rinsed in tap water and shifted to the cold storage room. After the end of time soaked chickpea

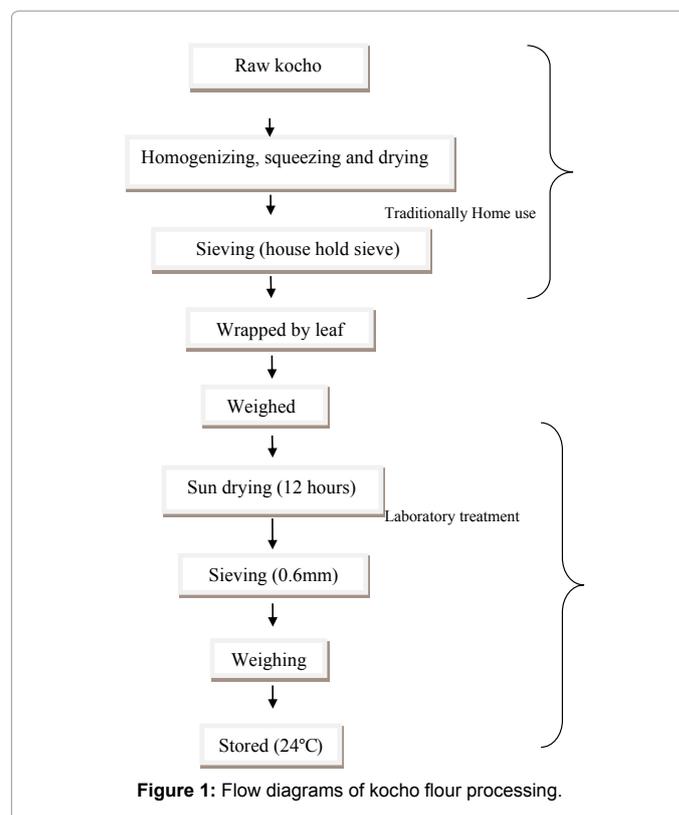


Figure 1: Flow diagrams of kocho flour processing.

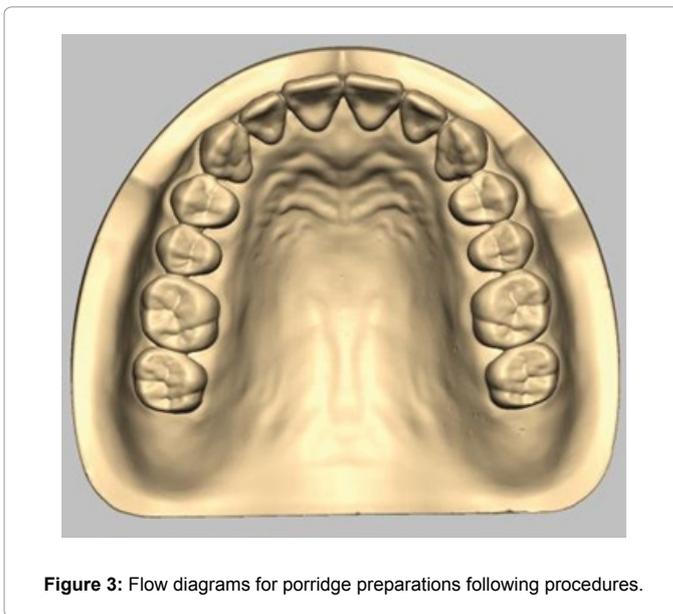
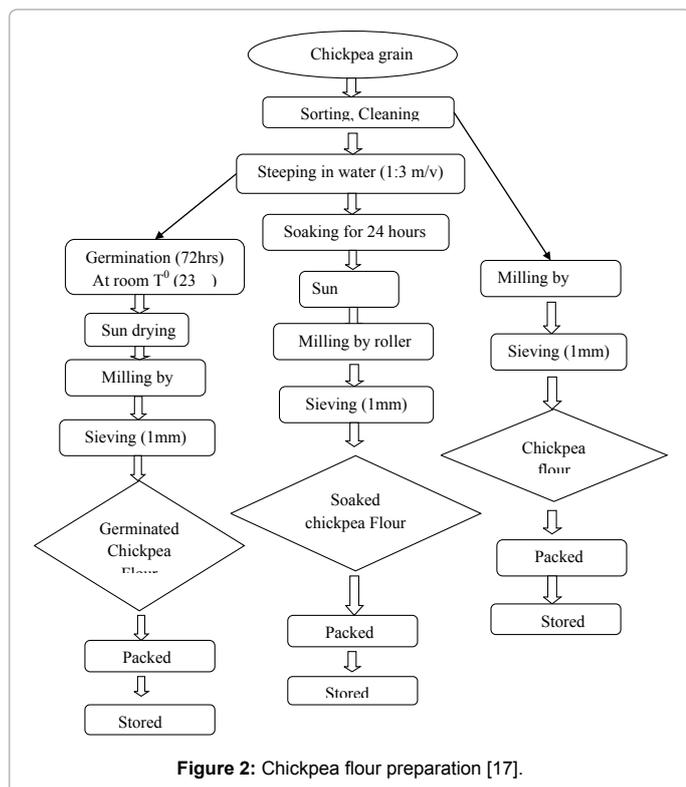
separately (independently) left for sun drying at freezer bags. The soaked chickpea was allowed to drain. The soaked chickpea was then spread on sacks for 48 hours under sunlight until dry (Figure 2).

Germination: The soaked chickpea was allowed to be exposed at room temperature 23°C for 72 hours. It was germinated in plastic sieves covered with muslin cloth with frequent watering. The unimpeded water was discarded and the soaked chickpeas were rinsed twice by boiled cooled water to avoid post contamination during germination. Water was poured once daily to provide moistening during sprouting. After 72 hours, chickpea that did not germinate was discarded and germinated seeds were removed from the plastic sieves, seed coats removed manually and samples placed in plastic bags. After germination, it left over in freezer bags for sun drying. Thereafter, germinated chickpeas were dried for 48 hours under sunlight. The same procedure has conducted a newly germinated chickpea at 25 hours [18]. After these treatments, chickpea was dried followed by milling and sieving at (1 mm) (Axel Kistner, England)-to produce chickpea flour (Figure 3).

Treatments and chickpea flours preparation

Porridge preparation: Porridges were prepared from the composite flour and other essential ingredients (salt, water, and oil). The porridge was prepared with the proportion of water to flour ratio of 6:1. Five grams of sugar was added to the porridge method used by Ocheme and Chinma [19]. Flours were mixed in a saucepan (pot with handle) to be homogenized with cold water then added in hot water and string continuously for 10 min until the mixed one completely converted into porridge, at 100°C to 120°C until soft porridge formed. Then it was removed from the stove and allowed to cool to 30°C to make ready-to-serve.

Proximate composition determination: Moisture content, ash,



crude protein, crude fiber and crude fat of analysis of product were done in duplicates using the methods described by AOAC [20]. Carbohydrate was calculated by difference.

Carbohydrate: The carbohydrate content was determined by difference:

Utilizable Carbohydrates (%) = 100 - (Moisture + Protein + Fat + Ash + Fiber)

Gross energy: Values of carbohydrate, protein, and fat obtained in the proximate analysis were multiplied by their respective Atwater's conversion factors (4 kcal/g for protein, 9 kcal/g for fat and 4 kcal/g for carbohydrates).

$$\text{Gross Energy} \frac{\text{kcal}}{100 \text{ gram}} = 4 \text{ kcal} \times \text{Protein} + 4 \text{ kcal} \times \text{Carbohydrate} + 9 \text{ kcal} \times \text{fat}$$

Determination of functional properties

Bulk density (BD): The bulk density of the composite flour was determined according to Gernah et al. [21] procedure. Ten gram of the flour was measured and put into 100 mL measuring cylinder. The cylinder was tapped until a constant volume was obtained. Bulk density was then measured by reading the difference of volume in the measuring cylinder.

$$\text{Bulk density of composite flour} = \frac{\text{weight (g)}}{\text{volume (cm}^3\text{)}}$$

Water absorption capacity (WAC): About 1 gram composite (W_1) flour was taken into a centrifuge tube and 6 mL of distilled water was added and mixed thoroughly according to Meseret [22] procedure. Then, the sample was allowed to stand for 30 minutes and centrifuged at 4000 rpm for 15 minutes with a centrifuge. The supernatant was then decanted and the sample weighed (W_2) again. The water retained in the sample was calculated as the amount of water absorbed by the sample. The results were expressed as weight of water absorbed in grams per 100 gram dry sample.

$$\text{Water absorption capacity} = \frac{W_2 - W_1}{W_0}$$

here: W_2 =weight of the sample after centrifugation, W_1 =weight of the sample before centrifugation and W_0 =weight of original sample taken

Oil absorption capacity (OAC): One gram (W_1) of composite flour sample was measured in and taken in a centrifuge tube by using the procedure of Mepba et al. [22]. After putting the sample in a centrifuge tube, its weight was recorded. Six milliliters of refined vegetable oil was added to the flour and centrifuged at 4000 rpm for 25 minutes with the centrifuge. The supernatant or free oil was decanted and the sample in the centrifuge tube was weighed again (W_2) to calculate the oil in the sample.

$$\text{Oil absorption capacity} = \frac{W_2 - W_1}{W_0} \times 100$$

Where: W_2 =weight of the sample after centrifugation, W_1 =weight of the sample before centrifugation and W_0 =weight of original sample taken.

The viscosity of the porridge: The cooked porridge was placed in a water bath maintained at 40°C (the temperature at which viscosity measurement was taken). Brookfield viscometer was used to measure the porridge viscosity (in centipoises, cps) using spindle number 4 at a shear rate of 50 rpm. Brookfield Viscometer of all porridges was measured using the procedure of Shemelis [9]. The consistometer has a 100 mL reservoir, which is filled full. The gate on the reservoir is then opened, allowing the sample to flow. The device has a level track 240 mm long with graduated markings every 5 mm. The viscosity is reported as the distance traveled by the leading edge of the porridge flow (to the nearest 5 mm) in 30 seconds. All porridges were allowed to cool at room temperature to 40°C before loading the consistometer.

Calculation Viscosity, (Ns/m²)=reading × factor

Minerals analysis (Calcium, Magnesium, and Zinc): The mineral contents of Ca, Mg and Zn in products were measured using Atomic Absorption Spectrophotometer (AAS) (Analytikjena AG, Germany) at a wavelength of 324.8 nm, 213.9 nm and 248.3, respectively [20] method 999.11. Ash was obtained after dry ashing at 525°C and treated with 7 mL of 6N HCl to wet it completely and 15 mL of 3N HCl was added and heated on the hot plate until the solution just boils. Then, it was cooled and filtered. Further 10 mL of 3N HCl was added to the dish and heated until the solution just boils. Finally, the mixtures were cooled and filtered into the graduated flask. Five grams of samples were placed in a previously weighed porcelain crucible and heated. The resulting white ash was weighed, dissolved in 3 ml of concentrated nitric acid (HNO₃) and diluted with distilled water in a 25 mL calibrated flask. Using atomic absorption spectrophotometer a calibration curve was prepared by plotting the absorption or against concentration in mg/100 g. Reading of metal concentrations that correspond to the absorption or emission values of the samples and the blank was taken from stand curve Hernandez et al. [23]. The metal contents were calculated by using the below formula:

$$\text{Water absorption capacity} = \frac{W_2 - W_1}{W_0} \times 100$$

Where: W=weight of samples (g), V=volume of extract (ml), A=concentration of sample solution (ml) and B=concentration of blank solution (ml).

Sensory evaluation of porridge: Sensory acceptability in terms of color, appearance, texture, flavor, aroma, taste and overall acceptability of porridge was evaluated by thirty untrained panelists using five points

of hedonic scales in order to assess the acceptability of each product. The relative importance of each product was compared numerically on a scale of 1 to 5 (where 1=very much disliked, 2=disliked, 3=neither disliked nor liked, 4=liked, and 5=very much liked.). The samples were presented one by one in identical containers, coded with three-digit random numbers. Potable water was provided for mouth rinsing in between evaluations. In addition, covered cups were also provided for panelists for spitting samples in case they would not wish to swallow the samples after testing [24].

Data analysis: Proximate, minerals, functional properties and sensory evaluation data were analyzed using one way analysis of variance (ANOVA) model using the SAS software program, version 9.3.1. The results of these parameters were reported as an average value of triplicate analysis (mean ± SD). Differences between treatments were determined by Fisher's Least Significance Difference (LSD) method and statistical significance was set at p<0.05.

Results and Discussion

Proximate composition

Moisture content: As shown in Table 1, the moisture contents the study sample KGC₆ (6.43%) has the highest moisture content prepared from 60% kocho with 40% germinated chickpea flour than control. And KUC₁ (5.78%) had lowest moisture contents which prepared from 70% kocho with 30% unsoaked chickpea flours than control. The interaction of germinated chickpea flour also observed a highly significant difference (p<0.05). A similar result was reported by Beruk et al. [25] in the study conducted on the effect of blending ratio and processing technique on physicochemical composition, functional properties and sensory acceptability of quality protein maize-based complementary food. But the products of kocho to chickpea composite blended product had lower moisture contents than and control. This probably was due to the high water binding capacity of the starch in the food products of kocho flour. Therefore, as the increase of kocho flour composite products the moisture contents also increased.

Crude protein content: Table 1 shows that the protein content of the porridge products were in the range from 1.14% (control) to 13.65±0.14 (KSC₅). In this study KSC₅ (13.65%) had highest protein content prepared from 60% kocho with 40% soaked chickpea flour and KSC₂ (10.23%) had lowest contents which prepared from 70% kocho with 30% soaked chickpea flours. This indicates that the protein content of product increased with an increase in the proportion of soaked chickpea flour. This might be due to the high amount of protein in soaked chickpea flour. There are comparative results (14.9%) were recorded on nutritive value and sensory acceptability of corn and kocho-based foods supplemented with legumes for infant feeding in

Product	Kocho	Raw Chickpea	Soaked Chickpea	Germinated Chickpea
KC ₀	100	0	0	0
KUC ₁	70	30	0	0
KSC ₂	70	0	30	0
KGC ₃	70	0	0	30
KUC ₄	60	40	0	0
KSC ₅	60	0	40	0
KGC ₆	60	0	0	40

K-Kocho, C-Chickpea, S-soaked, U-Untreated, G-Germinated; KC₀: (100:0:0% control), KUC₁: 70:30%, KSC₂: 70: 30%, KGC₃: 70:30%, KUC₄: 60: 40%, KSC₅: 60: 40%, and KGC₆: 60: 40%

Table 1: Formulation of composite flours from kocho and chickpea for preparing porridge (%).

Southern Ethiopia. Therefore, the finding of this study depicted that the addition of soaked chickpea flour is a potential way to increase the nutritional value of traditional Ethiopian food (porridge).

Crude fat: The fat content of the developed composite flour products were varied 1.27% (control) to 0.32% (KSC₅). In the results fat content was showed highest value significant difference (p<0.05) in the product KGC₃ (0.44%) which prepared from kocho with germinated chickpea flour. The studied fat content of current study was also lower than the effect of blending ratio and processing technique on physicochemical composition, functional properties and sensory acceptability of quality protein maize-based complementary food which was 4.68% [25].

Ash content: The result in Table 1 depicts the ash content of products were ranged 2.99% (KSC₃) to 3.14% (KSC₆). In this study, the ash content was showed a significant difference (p<0.05) in the product composite flour. The ash contents of the products were decreased as the increasing level of processed chickpea flours increased. This might be due to the high contents of ash in kocho flours as compared to chickpea flour. The studied formulated porridge products ash content value is within the Minaleshewa [26] studies, commercially available ensete (Enset ventricosum (Welw.) Cheesman) food products, (kocho and bulla) for major minor and trace elements which were ash content value of 1.7%.

Crude fiber content: The fiber contents of products were in the range of 5.29% (KSC₂) to 5.61% (KSC₆). The fiber contents were showed a significant difference (p<0.05) in the porridge product. This study value of crude fiber content is higher than the reported study conducted in complementary food prepared from maize and chickpea Anigo et al. [27]. This could be dehulling of husks did not carry out in the study, and kocho itself also has high fiber content, which was supported [28,29]. And soaking decreased the fiber content of product flours from KGC₃ and 6 (5.44% and 5.61%) to KSC₂ and 5 (5.29% and 5.37%), respectively. This study observation is in agreement with the previous studies value conducted on complementary food prepared from germinated maize and chickpea [17]. Fiber contents of formulated porridge products were higher as the increase processed chickpea flour than a study conducted in complementary food prepared from quality protein maize [25].

Carbohydrate: The carbohydrate content of this study KSC₂ (80.43%) had the lowest content prepared from 70% kocho with 30% soaked chickpea flour than control. The carbohydrate of the product value showed significance difference (p<0.05) among the porridge. The carbohydrate content of the current formulations was more similar to that of reported by Sadana et al. [30] who found 47.1% to 69.74% carbohydrate from weaning food based on germinated chickpea. The lower carbohydrate contents in the studies could be due to a higher amount of moisture content (>46%) in the composite flours and could be caused by processing methods and fermentation time [29].

Gross energy: As it is shown in above Table 1 the gross energy of composite flour products varied from KGC₅ (364.08%) to KGC₂ (366.24%). In this study KUC₁ (366.86 kcal/100 g) had lowest gross energy content in porridge product prepared from a combination of 70% of kocho with 30% of un-soaked chickpea flour when compared with control The KGC₆ (363.37 kcal/100 g) had also lowest energy content observed in products prepared from 60% kocho with 40% germinated chickpea flour than control. The gross energy content of the product showed significance difference (p<0.05).

According to Walker [31], the recommended daily allowance of energy for complementary foods in developing countries is 370 to 420 kcal per 100 gm. The energy contents in this study were in the range of 366.86 to 363.37 kcal per 100 gm which can slightly near to satisfy the minimum energy requirements of the recommended daily allowance. A decrease in the gross energy level was observed with an increase in the proportion of chickpea flour.

Functional properties

The result table Table 2 showed the functional properties of the products.

Bulk density: The bulk density values were found between 0.91 gm/mL (KSC₂) and 1.52 g/mL (KC₀) (Table 2). The studied value of, KUC₁ (1.19 gm/mL) had the lowest bulk density which prepared 70% of kocho with 30% un-soaked chickpea flour than control. The KSC₅ (0.91 gm/mL) has the lowest bulk density which prepared from 60% of kocho with 40% soaked chickpea flour when compared with control. The bulk density of the product showed significance difference (p<0.05) among the composite flour products. This value is slightly higher than the reported value for sweet potato: soya bean based complementary flour (0.56 gm per ml to 0.96 gm per ml), popcorn based complementary flour (0.56 gm to 0.86 gm per ml) and Soya bean: Maize Flour (0.61 gm per cm³ to 0.73 gm per cm³) [32,33]. Chickpea flour prepared from germinated and soaked ingredients showed a decrement in bulk densities while the amount of chickpea incorporated increased in the present study. A similar result was also reported in the study conducted on the effect of blending ratio and processing technique on physicochemical composition, functional properties and sensory acceptability of quality protein maize-based complementary food reported by Beruk et al. [25].

Water absorption capacity (WAC): Water absorption capacity (WAC) of composite flour product in this study was between 131.48 mL/gm (KUC₁) to 147.50 mL/gm (KGC₆). The KGC₆ (147.50 mL/gm) had the highest water absorption capacity which prepared 60% of kocho with 40% germinated chickpea flour than control. The KUC₁ (131.48 mL/gm) had also the highest bulk density which prepared from 70% of kocho with 30% un-soaked chickpea flour than control. A comparable result was exhibited on QPM: soya bean blends complementary food

Product	Moisture	Crude Fiber	Crude Fat	Ash	Crude Protein	CHO	Energy (kcal/100 g)
KC ₀	2.85 ± 0.28 ^c	5.56 ± 0.04 ^{ab}	0.16 ± 0.10 ^e	3.26 ± 0.03 ^a	1.14 ± 0.01 ^d	92.59 ± 0.05 ^a	376.36 ± 0.40 ^c
KUC ₁	5.78 ± 0.32 ^e	5.31 ± 0.04 ^d	0.42 ± 0.13 ^d	3.03 ± 0.02 ^b	10.48 ± 0.04 ^c	80.29 ± 0.21 ^b	366.86 ± 0.22 ^a
KSC ₂	5.88 ± 0.02 ^b	5.29 ± 0.05 ^{bc}	0.40 ± 0.03 ^c	3.06 ± 0.04 ^{bc}	10.23 ± 0.03 ^b	80.43 ± 0.21 ^c	366.24 ± 0.01 ^c
KGC ₃	5.97 ± 0.03 ^c	5.44 ± 0.03 ^{bc}	0.44 ± 0.13 ^c	3.04 ± 0.10 ^c	10.57 ± 0.12 ^{ab}	79.98 ± 0.10 ^{bc}	366.16 ± 0.13 ^b
KUC ₄	6.22 ± 0.02 ^c	5.48 ± 0.02 ^c	0.34 ± 0.15 ^{bc}	2.97 ± 0.12 ^c	13.56 ± 0.02 ^c	76.91 ± 0.22 ^b	364.94 ± 0.31 ^b
KSC ₅	6.39 ± 0.28 ^d	5.37 ± 0.06 ^b	0.32 ± 0.10 ^{bc}	2.99 ± 0.17 ^c	13.65 ± 0.14 ^{ab}	76.65 ± 0.04 ^{bc}	364.08 ± 0.21 ^{ab}
KGC ₆	6.43 ± 0.14 ^c	5.61 ± 0.01 ^{ab}	0.33 ± 0.02 ^b	3.14 ± 0.12 ^{bc}	13.18 ± 0.10 ^b	76.92 ± 0.14 ^{bc}	363.37 ± 0.32 ^b

Means ± SD with the different letter of superscripts in a column are significantly different (p<0.05). K-Kocho, C-Chickpea S-Soaked, U-Untreated, G-Germinated; KC₀: (100:0.0% control), KUC₁: 70:30%, KSC₂: 70:30%, KGC₃: 70:30%, KUC₄: 60:40%, KSC₅: 60:40%, and KGC₆: 60:40%, CHO-Carbohydrate

Table 2: Proximate composition (%) and gross energy of the products developed from kocho and chickpea.

effect of blending ratio and processing technique on physicochemical composition and functional properties of quality protein maize (QPM) based complementary food which was CB1 (131.50 mL/gm) to GB2 (147.50 mL/gm) Beruk et al. [25]. This is due to the addition of germinated and soaked chickpea flours in the products increase the result of water absorption capacity in the present study. This result agrees with finding on soya bean-maize flour blended cookies and soya: plantain flour [33,34].

Oil absorption capacity (OAC): According to Table 2 results, the oil absorption capacities (OAC) of products in this study were between 88.75 mL/gm (KUC₁) to 108.50 mL/gm (KGC₃). Therefore, KGC₃ (108.50 mL/gm) had higher oil absorption capacity which prepared 70% of kocho with 30% germinated chickpea flour than control. The KR₁ (87.98 mL/gm) had the lowest oil absorption capacity which prepared from 70% of kocho with 30% un-soaked chickpea flour than control. The oil absorption capacity of the product showed significance difference (p<0.05). This higher result could be observed for products having fewer amounts of fat contents in the study. In this study germination and soaking of chickpea increase the oil absorption capacity of composite flours. Similarly, increasing the amount of processed chickpea in kocho based foods increase the oil absorption capacity of the product to absorb oil per 100 gm which is agreed with cocoyam: soybean: crayfish flour blends.

Viscosity: Table 2 showed the viscosity of the porridge value ranged from 2179.00 cps (KGC₃) to 4278.00 cps (KUC₁). The porridge KUC₁ (4278.00 cps) had higher viscosity which prepared 70% of kocho with 30% un-soaked chickpea flour porridge compared with control porridge while the KGC₃ (2179.00 cps) had the lowest viscosity which prepared from 60% of kocho with 40% germinated chickpea flour than control. The studied viscosity value is lower than composite flour products mixed in the ratio of 15% w/v, the viscosities of composite flour products were between 2571 cps to 4269 cps reported by Beruk et al. [25]. However, the complimentary porridges prepared in developing countries are known with high viscosity which can limit the energy and nutrient need of children. The studied composite flour made from germinated and soaked significantly reduced viscosities which were 4278.00 cps to 2179.00 cps, respectively in the present study. Similar decrement was seen on the effect of blending ratio and processing technique on physicochemical composition, functional properties and sensory acceptability of Quality Protein Maize (QPM) based complementary food [25].

Mineral content

The mineral contents (Ca, Mg and Zn) of the products were presented in the following Table 3.

Calcium content: As shown in Table 3 the most abundant mineral

among the investigated elements (calcium) was ranged between 120.48 mg/100 gm (CR_s) to 618.04 mg 100 gm (KGC_s). The porridge KGC_s (618.04 mg/100 gm) had highest calcium content which prepared 70% of kocho with 30% germinated chickpea flour than control whereas, CR_s (120.48 mg/100 sgm) had the lowest content which prepared from 100% of chickpea recipe product when compared with control. The calcium content in the porridge products from the different blends was significantly different (p<0.05). The calcium content of the product increases with the increment of kocho proportion in the sample. The observed difference cloud is due to the higher amount of calcium found in the kocho flour. Similar increment calcium content was observed in Quality Protein Maize (QPM) based complementary food [25].

Magnesium content: The magnesium content of porridge samples was varied from 122.26 mg/100 gm (CR₁) to 302.01 mg/100 gm (KGC₃) (Table 3). The porridge KGC₃ (302.01 mg/100 gm) had highest magnesium content which prepared 70% of kocho with 30% germinated chickpea flour than control whereas, CR₁ (122.26 mg/100 gm) had the lowest content when compared with control. Magnesium content of the product showed significance difference (p<0.05) among the samples. This was due to the high contents of kocho flour product. There was an incremented result in the magnesium content from 122.26 mg/100 gm to 302.01 mg/100 gm with an increase in the proportion of processed chickpea flours. The observed result is due to the high magnesium content found in kocho flour as compared to the chickpea flour. Similarly [35,36] indicated that kocho and chickpea as good sources of minerals like magnesium.

Zinc content: The zinc content of the product samples were varied from 4.56 mg/100 gm (CR₁) to 31.63 mg/100 gm (KR₁) (Table 3). The porridge KR₁ (31.63 mg/100 gm) had highest zinc content which prepared 100% of kocho product than control and CR₁ (4.56 mg/100 gm) had the lowest content which prepared from 100% of chickpea recipe product when compared with control. The amount of zinc in this study was in the range between 4.56 to 31.63 mg per 100 gm which fulfilled 81% to 88.34% of the RDA for children aged 1-3 years is 3 mg Faber et al. [37]. The difference in the zinc content was highly significantly (p<0.05) due to the interaction of different ratio of processed kocho flour. As indicated in Table 4, zinc content decreased with an increased within the proportion of kocho flour because of the high content of zinc in kocho. WHO [11] reported the 270-500, 75-80 and 3 is an excellent source of Zinc. The cause for increasing the zinc content in the product, above RDA, was a high content of kocho flours in the composite flour.

Sensory evaluation

Sensory qualities are the main criteria that make the product to be liked or disliked. The degree of liking or disliking in hedonic scales, the researcher was discussed according to the following Table 3. The following scores were indicated acceptability (degree of liking) of

Product	BD (gm/ml)	WAC (ml/100 gm)	OAC (ml/100 g)	Viscosity (cps)
KC ₀	1.52 ± 0.02 ^a	131.20 ± 2.63 ^d	88.55 ± 1.46 ^c	4187.05 ± 11.97 ^a
KUC ₁	1.11 ± 0.06 ^e	131.48 ± 1.85 ^d	88.75 ± 1.06 ^c	4278.00 ± 11.93 ^a
KSC ₂	1.06 ± 0.03 ^{ab}	138.52 ± 2.32 ^{bc}	92.00 ± 0.95 ^b	2313.50 ± 50.43 ^d
KGC ₃	0.93 ± 0.04 ^d	141.49 ± 0.71 ^{bc}	108.50 ± 4.95 ^a	2380.00 ± 11.78 ^d
KUC ₄	1.19 ± 0.04 ^{bc}	135.53 ± 0.71 ^c	98.00 ± 0.91 ^b	3616.00 ± 40.96 ^d
KSC ₅	0.91 ± 0.17 ^d	144.00 ± 1.41 ^{ab}	102.32 ± 1.89 ^{ab}	2387.50 ± 10.61 ^{cd}
KGC ₆	0.92 ± 0.04 ^d	147.50 ± 1.95 ^a	101.50 ± 4.95 ^{ab}	2179.00 ± 12.32 ^c

Means ± SD with the different letter of superscripts in a column are significantly different (p<0.05). K-Kocho, C-Chickpea S-Soaked, U-Untreated, G-Germinated; KC₀: (100:0.0% control), KUC₁: 70:30%, KSC₂: 70: 30%, KGC₃: 70:30%, KUC₄: 60: 40%, KSC₅: 60: 40%, and KGC₆: 60: 40%,Bd- Bulk Density, WAC- Water Absorption Capacity, OAC- Oil Absorption Capacity

Table 3: Functional properties of composite flour products developed from kocho and chickpea.

porridge. The sample porridge sensory acceptability scores were ranged for appearance (2.57% to 4.51%), color (2.54% to 4.63%), texture (2.66% to 4.54%), flavor (2.67% to 4.60%), aroma (2.58% to 4.60%), taste (2.63% to 4.54%), and overall acceptability (2.84% to 4.82%).

Sensory evaluation of the porridge developed from composite flours:

Appearance: The appearance of the porridge was ranged between 2.57% (T₀) to 4.51% (T₆). The, T₆ (4.51%) obtained the highest mean score which prepared 60% of kocho with 40% germinated chickpea flour than control. The appearance of the porridge showed significance difference (p<0.05). Similar results were seen in a study conducted on the formulation of complementary foods from amaranth, chickpea and maize Zebdewos et al. [38].

Colour: The color of the porridge was ranged between 2.54% (T₀) to 4.63% (T₆). The T₆ (4.63%) obtained the highest mean score which prepared 60% of kocho with 40% germinated chickpea flour than control. The color of porridge showed a significant difference (p<0.05). Addition of germinated chickpea flour increases the colour of the porridge. This result agrees with finding on nutritive value and sensory acceptability of corn and kocho-based foods by Abebe et al. [8].

Texture: The texture of the porridge was ranged from 2.66% (T₀) to 4.54% (T₆). The, T₆ (4.54%) obtained the highest mean score which prepared 60% of kocho with 40% germinated chickpea flour than control. The texture of porridge showed a significant difference (p<0.05).

Flavor: The flavor and smell of the products depend on the volatile constituents of raw material. Flavor of the porridge was ranged from 2.67% (T₀) to 4.60% (T₆). The rest comparative results (T₀) 2.67% (T₁) 3.21% (T₂) 3.61% (T₃) 4.13% (T₄) 3.52% (T₅) 4.03% and (T₆) 4.60% were observed results. Therefore, T₆ (4.60%) obtained the highest mean score which prepared 60% of kocho with 40% germinated chickpea flour than control. The flavor of porridge showed a significant difference (p<0.05) and the interaction of germinated chickpea flour also observed a highly significant difference (p<0.05). Similarly, increased flavor score was

recorded on the formulation of complementary foods from amaranth, chickpea and maize [38].

Taste: The taste of the porridge was ranged from 2.63% (T₀) to 4.54% (T₆). In the comparative results (T₀) 2.63% (T₁) 3.12% (T₂) 3.58% (T₃) 3.97% (T₄) 3.58% (T₅) 4.08% and (T₆) 4.54% were observed results. Therefore, T₆ (4.54%) obtained the highest mean score which prepared 60% of kocho with 40% germinated chickpea flour than control. The flavor of porridge showed a significant difference (p<0.05) and the interaction of germinated chickpea flour also observed a highly significant difference (p<0.05). A similar result was seen in porridges prepared from germinated maize fortified with defatted sesame, germinated maize [19].

Overall acceptability

In the present study ranking test of formulated porridge results was ranged from 2.84% (T₀) to 4.82% (T₆). The T₆ (4.82%) obtained the highest mean score which prepared 60% of kocho with 40% germinated chickpea flour than control. The flavor of porridge showed a significant difference (p<0.05). A contrary result was recorded seen in a study conducted on processing technique on physicochemical composition, functional properties and sensory acceptability of quality protein maize-based complementary foods [25]. This is due to processing methods of kocho and chickpea flours.

As indicated in Table 4, the highest scores in color, appearance, flavor and overall acceptability were recorded in porridge prepared from 60% kocho flour (T₆); whereas, the lowest score for all sensory attributes was exhibited in porridge prepared from 100% kocho flour (control) (T₀). Likewise, the highest score for texture and taste was recorded in porridge prepared from 60% of kocho flour with 40% chickpea soaked and germinated together (T₅ and T₆). Color is a very important criterion for the initial acceptability of the product by the panelist. As the level of kocho and chickpea flour in blends was increased, the color of the porridges changed from dark to white brown. Vision plays a major role in the sensory analysis of the appearance of food can have a major effect on its acceptability. Moreover, white browning of the porridges

Products	Calcium	Magnesium	Zinc
KC ₀	501.36 ± 3.54 ^{bc}	182.88 ± 0.01 ^d	31.04 ± 0.32 ^c
KUC ₁	562.26 ± 0.10 ^c	275.36 ± 0.17 ^c	22.09 ± 0.00 ^d
KSC ₂	575.01 ± 0.15 ^{bc}	284.34 ± 0.03 ^c	22.68 ± 0.10 ^{cd}
KGC ₃	618.04 ± 0.06 ^{bc}	302.01 ± 0.22 ^{bc}	23.10 ± 0.00 ^{cd}
KUC ₄	483.76 ± 4.95 ^b	253.52 ± 0.13 ^{bc}	20.43 ± 0.00 ^{bc}
KSC ₅	520.93 ± 0.10 ^b	257.96 ± 3.54 ^b	21.34 ± 3.54 ^b
KGC ₆	540.66 ± 0.07 ^a	265.54 ± 0.03 ^a	20.63 ± 0.15 ^a

Means ± SD with the different letter of superscripts in a column are significantly different (p<0.05). K-kocho, C- chickpea, S-soaked, U-untreated, G-germinated; KC₀: (100:0.0% control), KUC₁: 70:30%, KSC₂: 70: 30%, KGC₃: 70:30%, KUC₄: 60: 40%, KSC₅: 60: 40%, and KGC₆: 60: 40%

Table 4: Mineral content of composite flour products of kocho-chickpea porridge (mg/100 gm).

Porridges	Appearance	Colour	Texture	Flavour	Aroma	Taste	Over all acceptability
KC ₀	2.57 ± 1.07 ^e	2.54 ± 1.06 ^e	2.66 ± 1.10 ^e	2.67 ± 1.06 ^e	2.58 ± 1.02 ^d	2.63 ± 0.97 ^e	2.84 ± 1.12 ^e
KUC ₁	3.10 ± 0.91 ^d	3.24 ± 0.96 ^d	3.16 ± 0.90 ^d	3.21 ± 0.88 ^d	3.32 ± 0.87 ^c	3.12 ± 0.89 ^d	3.28 ± 0.87 ^d
KSC ₂	3.63 ± 0.77 ^c	3.63 ± 0.85 ^c	3.52 ± 0.95 ^c	3.61 ± 0.85 ^c	3.56 ± 0.93 ^c	3.58 ± 0.83 ^c	3.71 ± 0.92 ^c
KGC ₃	4.06 ± 0.86 ^b	4.03 ± 0.95 ^b	3.97 ± 1.01 ^b	4.13 ± 0.89 ^b	3.98 ± 1.04 ^b	3.97 ± 1.01 ^b	4.30 ± 0.83 ^b
KUC ₄	3.61 ± 0.93 ^c	3.75 ± 0.99 ^c	3.60 ± 0.88 ^c	3.52 ± 0.91 ^c	3.54 ± 0.78 ^c	3.58 ± 0.93 ^c	3.74 ± 0.84 ^c
KSC ₅	4.15 ± 0.68 ^b	4.11 ± 0.81 ^b	4.02 ± 0.70 ^b	4.03 ± 0.82 ^b	4.17 ± 0.68 ^b	4.08 ± 0.71 ^b	4.34 ± 0.60 ^b
KGC ₆	4.51 ± 0.70 ^a	4.63 ± 0.66 ^a	4.54 ± 0.70 ^a	4.60 ± 0.66 ^a	4.60 ± 0.64 ^a	4.54 ± 0.62 ^a	4.82 ± 0.46 ^a

Means ± SD with the different letter of superscripts in a column are significantly different (p<0.05). K-Kocho, C-Chickpea, S-Soaked, U-Untreated, G-Germinated; KC₀: (100:0.0% control), KUC₁: 70:30%, KSC₂: 70: 30%, KGC₃: 70:30%, KUC₄: 60: 40%, KSC₅: 60: 40%, and KGC₆: 60: 40%

Table 5: Effect of soaking, germination and blending ratio on sensory acceptability of porridge from kocho and chickpea.

could also occur due to Millard reactions, as the protein contributed by chickpea flour must have reacted with sugar when processing [39].

The flavor and smell of the products depend on the volatile constituents of raw material. For flavor perception, again there was a significant difference ($P < 0.05$) in flavor among the samples. The results on flavor preference suggested that 40% chickpea flour porridge was more accepted than the 30% chickpea flour.

The taste was influenced by the quality of the raw materials used in the processing of porridges. The germinated chickpea flour supplemented porridge performed better than the other un-soaked and soaked chickpea flour blends. A current study was similarly to Abebe et al. [8] developed complementary foods by addition of kidney beans, corn, and pumpkin flour at 40 percent level into kocho flour was highly acceptable.

The overall acceptability expresses how the panelists accept the porridge generally. In the current study, the maximum amount of kocho-based porridge with chickpea flour 40% addition was acceptable which is the similar finding with a study conducted on a formulation of a complementary food fortified from corn and kocho-based foods Abebe et al. [8] Table 5.

Conclusion

The product which prepared from 60% kocho with 40% germinated chickpea flour seen highest moisture content. The product which prepared from 60% kocho with 40% soaked chickpea flour observed highest protein content. Therefore, blending chickpea flour can minimize fiber contents form porridge. For carbohydrate content the product which prepared from 70% kocho with 30% soaked chickpea flour seen the lowest result. In energy content, the product, prepared from a combination of 70% of kocho and 30% of unsoaked chickpea flour observed the lowest gross score. The bulk density the product prepared from 70% of kocho and 30% unsoaked chickpea flour had the lowest content. The product prepared from 60% of kocho and 40% germinated chickpea flour had the highest water absorption capacity. Whereas the oil absorption capacity results in the product prepared from 70% of kocho and 30% germinated chickpea flour was observed highest content. The porridge prepared from 70% of kocho and 30% unsoaked chickpea flour seen highest viscosity score. The product which prepared from 70% of kocho and 30% germinated chickpea flour was observed highest calcium and magnesium content. In zinc content, the product prepared from 100% of kocho recipe flour seen highest content score. Therefore, blending chickpea flour with kocho can minimize the high contents of zinc. The porridge which prepared from 60% of kocho and 40% germinated chickpea flour had the highest mean score for all of the sensory attributes and accepted by most panelists. It has been shown that blending of chickpea flour up to a level of 40% would produce more nutritional and acceptable products. The more the chickpea used in a mixture, the higher its nutritive value. It can be an important grain for combating malnutrition enhancing food security. The results indicated that the addition of chickpea in kocho was able to increase the protein, minerals, energy and crude fiber contents. Protein-energy malnutrition which affects children in case of eating protein low food kocho, can be minimized by blending chickpea flour when porridge preparation. It is better if chickpea flour blended with kocho to minimize protein-energy malnutrition problem from preschool children.

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