CPQ Nutrition (2018) 1:4
Research Article

The Physico-Chemical Composition and Sensorial Quality of Kocho Bread Blended with Wheat *(Triticum aestivum)* and Soybean *(Glycine max)* Flour

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Received: 03 July 2018

Published: 07 August 2018

Keywords: *Enset; Kocho; Composite Flour; Bread; Sensory Quality*

Abstract

Enset (*Enset ventricosum*), edible starchy indigenous tuber crop used as staple and co-staple food source for more than 10 million of Ethiopians. Kocho is a thick paste like anaerobically fermented starchy product extracted from enset in the presence of starter culture. Kocho based composite bread is getting attention as the nutrient density and sensory attribute is improved to enhance likeability and diversify enset as an alternative food security crop. The objective of this study was to evaluate the physico-chemical and sensorial property of Kocho bread blended with white wheat and soybean flours. Kocho flour was added to 40% maximum, soybean flour was fixed at 15% blended proportionally with white wheat flour for bread making. The acceptability, proximate composition and mineral content was studied. The result shows incorporation of white wheat and soybean to kocho enhances the nutritional profile and significantly affects the likability of the most important bread sensory attributes. The proximate composition, mineral content and sensory quality of the composite bread was improved. The crust and crumb was affected with the increased substitution of kocho and soybean. Up to 40% kocho flour addition was acceptable for the important sensory attributes of bread. With kocho and soybean substitution the color of the bread was changed from white to brown (light darker color) affects the acceptability. The crumb structure of the bread with increased kocho substitution was observed grainy, sponginess and leathery. The proximate composition and mineral content was much improved with 40% kocho and 15% soybean addition. To prevent the prevalence of the protein energy malnutrition in the community where kocho is staple food, blending is important with cereals and legumes to balance the nutrient profile, enhance the likability and functional quality and use as a promising food security crop.

Introduction

Enset (*Enset ventricosum*), a starchy edible tuber crop [1-5] and Ethiopian indigenous species of the separate genus of the banana family, named `false banana' with considerable variation and adaptation [2,4]. Enset plant is 4 to 13m height, 1.5 to 3.0 m pseudostem circumference, 2 to 5m length of the pseudostem, 4 to 6m length of leaves and 0.6 to 0.9 m, width of leaves [6]. Enset is used as staple and/or co-staple food source for more than 10 million of Ethiopians [4] due to drought tolerance and high yield [7]. The harvesting process is labors and time taking includes, removal of the fleshy pseudostem and pulp extraction called decortication by a special wooden board pressed through a wooden sieve to collect a thick paste called kocho, bulla and amicho [2,8]. The thick paste (kocho) is anaerobically fermented in the underground for about 15 days to months) catalyzed with yeast (5 days' sun dried) from the chopped rhizome to improve the edibility and functionality [9,10] and lactic acid bacteria microflora [8]. Fermentation affects the characteristic organoleptic profile, nutrient availability and microbiological safety against pathogens in kocho [11]. Fermented Kocho is popular and commercialized in powder form for baking (bread, injera), porridge, drinks consumed with and without vegetable [2,12]. Kocho and bulla provides high energy but it lacks protein to causes protein malnutrition [2,13] which is prevalent due to the imbalance demand and supply of food resources, imbalanced price and policy barriers [14,15].

Wheat (*Triticum aestivum L*) is the most important ingredient in the bakery industry. The wheat cultivar is qualified for its use based on hardness, color, chemical composition, agronomic property and end use characteristics. Hard wheat Varity is known with high protein starch matrix and good bread making property [16,17]. Nevertheless, the gluten protein in wheat is triggering an immune mediated inflammatory disorder of the small intestine when ingested called Celiac disease (CD). As a result, the incidence of the CD prompt use of alternative gluten free crops, use of composite flour and technical modification to eliminate gluten toxicity, as the nutrition therapy is the only treatment of individuals susceptible to Celiac disease (CD) [18,19]. Modification of the fermentation process and addition of gliadin hydrolyzing enzymes (sourdough lactobacilli and fungal proteases) eliminates or reduce gluten toxicity) [19]. The use of non-wheat or composite flour have been common for bread making to reduce the burden of gluten toxicity. However, replacement of gluten in bread making presents a significant technological challenges due to the low baking performance and unfortunate organoleptic quality of the bread. Soybean (*Glycine max L*) is intentionally added to supplement the protein content and improve the organoleptic profile of kocho based bread such as; crust color, crumb body, resilience, toasting characteristics and enhance shelf life due to the presences of essential fatty acids and amino acids [15,20,21].

Bread making is a complex process includes mixing and kneading, fermentation, proofing and baking. The use of straight dough making process; flour, water, yeast, salt and baking powder mixed once at the start.

Fermentation provides improved dough loaf volume, bread crumb and crust quality and flavor profile. The nature of starch quality affects the heat penetrance phenomena and the overall appearance of bread. Addition of yeast facilitates hydrolysis, and integration of starch - protein to affects gas expansion to allow ease heat penetrance and improved organoleptic profile. The baking process at the specified time temperature combination to gelatinize the starch and expansion [22].

Bread

Bread, the most commercially and traditionally acceptable food, produced from single food crop or composite food crops around the world [23-26]. The composite flour based bread is gaining a bigger attention due to the integration of essential nutrients, increasing the nutrient density and functionality to the final product [27-35]. The consumer perception of the composite flour based products, including bread is very subjective, depends on individual consumer preference due to the social, demographic and environmental factors associated with sensory sensation intimately linked to freshness [31,35-38]. Bread making processes and recipes are important parameters for bread quality and acceptability [36].

Figure 1: *Kocho flour Processing (modified method of Tiruha Habte et al., 2014) [37]*

Materials and Methods

Material Preparation

Kocho, soybean and white wheat flours were used for the preparation of bread. Fermented Kocho purchased from the local farmers in Siltie zone, SNNPR of Ethiopia was prepared according to the method described by Yewelsew (2006) [32]. The fermented kocho was sundried, milled with laboratory miller, sieved (250 μm mesh size sieve) and packed in high density polyethylene bags for further work. The soya bean grain collected from Hawassa Agricultural Research Center, cleaned, dried and flour was prepared. The soya bean grain was soaked in distilled water for 10 minutes to remove the hull and broken in grits using attrition miller. The soya grit boiled in distilled water at 100˚C for 5 minutes to remove trypsin protein inhibitor, reduce the beany flavor and sun dried. The dried soybean was milled using hammer mill, sieved (250μm mesh size sieve) and packed in high density polyethylene bags. White wheat flour directly purchased from Hawassa flour factory. Preliminary study was conducted (1) biscuit making performance of kocho blended with white wheat and soybean flours, unfermented with 10-15 minutes resting time and baked at 180˚C and (2) optimization of composite flour formulation and adjustment of the optimal bread baking condition (appropriate time-temperature combination). Four combinations of composite flour and two controls was prepared. The blends of the flour referred to as 10KF, 10% kocho: 75% white wheat: 15% soybean flours; 20KF, 20% Kocho: 65% white wheat: 15% soybean flours, 30KF, 30% kocho: 55% white wheat: 15% soybean flours, 40KF, 40% kocho: 45% white wheat: 15% soybean flours respectively and two control samples; 0KF, 100% white wheat flour (positive control) and 100KF, 100% kocho flour (Negative Control). Bread was prepared according to figure 2 and the proximate composition, mineral content, and sensory quality (nine-point Hedonic scale) was analyzed in triplicates and SAS statistical software version 9.0 at significance level of $p \leq 0.05$ was used to analyze the data.

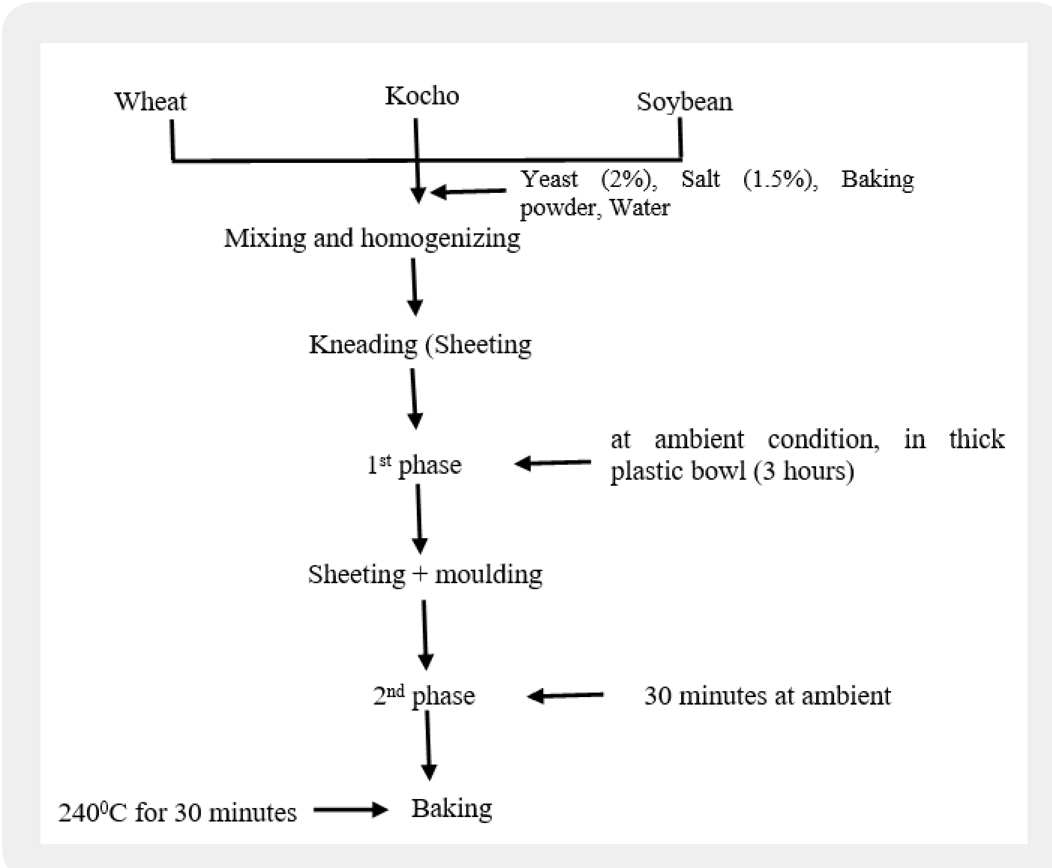

Figure 2: *Bread making Process from Composite flour (Kocho: White Wheat: Soybean Flours)*

Results and Discussion

Sensory Quality

The trial study conducted to check the biscuit making performance of kocho flour and kocho-wheat and soybean flours blend was found unacceptable. The biscuit was rocky, hard to bite with increased kocho substitution explains the starch quality of kocho might not be good for biscuit making. There is on studies conducted on the kocho starch quality but it was found sticky, compacted with high water holding capacity, limits the heat penetrance during baking. The external surface of the biscuit was burnet with uncooked internal part of the biscuit explains the starch quality and starch protein network formation is not that much strong and no expansion during biscuit making due too low heat penetrance property. The endogenous practices of flat bread baking of kocho, unleavened dough is rapped with enset leaves to allow slow heat penetrance and water spray to control burnet surface and improve the eating quality. This explains the starch quality is compacted and resistant to allow heat penetration. The optimal baking condition of kocho: white wheat: soybean composite bread was found 230˚C for 25-30 minutes [25] following the standard bread making procedure. The composite flour formulation; soybean was fixed at 15% to improve the protein quality, avoid the grainy appearance, beany flavor and Kocho flour was added at 40% maximum proportion based on the dough rheology (loaf volume) and sensory attributes of bread; crust color and crumb appearance. The result of the sensory quality (nine – point hedonic scale of likability) is presented in table 1 and figure 2; shows a significant difference with all sensory attributes of bread. The sensory quality shows a significant decrement with increased kocho substitution explains wheat is the preferable ingredient for bread with improved eating quality. During fermentation 2% yeast was added to enhance the loaf volume, gas retention and allow fast heat penetration.

Table 1: *The Sensory Quality of Bread from (0KF) 100% white wheat flour (10FS) 10% kocho, 75%white wheat & 15% soybean flours, (20KF) 20% kocho, 65% white wheat & 15%soybean flours, (30KF) 30% kocho, 55% white wheat &15% soybean flours, (40KF) 40% kocho, 45% white wheat &15% soybean flours and (100 KF) 100% kocho flour*

Bread Samples	Crust color	Crumb	Texture	Taste	aroma	Overall acceptability
0 KF	8.39±0.8[a]	8.04±09[a]	8.02±0.7[a]	8.16±0.8[a]	8.19±0.7[a]	8.21±0.7[a]
10 KF	7.83±0.9[b]	7.97±0.8[a]	7.61±0.9[a]	7.83±1.0[a]	7.69±1.0[b]	7.94±0.9[a]
20 KF	7.10±1.1[c]	7.16±1.0[b]	7.59±1.0[a]	7.20±1.1[c]	7.22±1.0[c]	7.19±0.9[c]
30KF	6.05±1.4[d]	6.13±1.2[c]	6.53±1.4[d]	6.69±1.2[d]	6.56±1.3[d]	6.45±1.1[d]
40 KF	5.41±1.3[e]	5.52±1.2[d]	6.47±1.2[d]	6.18±1.4[e]	6.16±1.4[e]	6.10±1.0[d]
100 KF	3.28±1.8[f]	3.91±2.0[e]	4.63±1.8[e]	4.28±1.6[f]	4.13±1.7[f]	4.18±1.6[e]

Crust color of the composite bread was darker with increased kocho substitution explains kocho starch was caramelized during thermal treatment and enhanced maillard reaction [1,40-43] in the presence of moisture, reducing sugars and amino acids [44] and the baking conditions (i.e. temperature, air speed, relative humidity, modes of heat transfer). Darker color, denser and compacted structure with regular porosity and moderate elasticity of crumb due to kocho substitution explained leathery texture and coarser bread [45] resulted from the starch and fiber network formation with kocho substitution [46]. The loaf volume was decreased with kocho substitution explains reduction of the particle rigidity of the swollen starch granules and fiber retains the moisture during baking limits the available water required for the gelatinization and no retention of gas affects the chewiness [47]. Soybean contributes improved crust color, crumb body, resilience and toasting characteristics of bread [20] but reduces the storability due to increased fat and protein content. The texture (hardness to bite) with kocho substitution due to the presences of fiber, low retrogradation property of starch, increased fat level, no/negligible protein (gluten) and the amounts of absorbed water during dough mixing tends to reduce expansion and harder to bite. Addition of soybean improves the bread texture. Conversely, increasing the starch level increases expansion and yields a softer bite [23,48]. The taste and aroma decreased significantly ($p < 0.05$) with kocho flour substitution level increased, the bread imparted kocho flavor resulted an intense after taste quality and process (fermentation) [32]. In general, the overall acceptability shows decrement with kocho substitution but up to 40% kocho addition shows acceptable for bread making composite flour development [24,49].

Proximate Composition

The results of the proximate composition (Table 2) of 45% white wheat: 40% Kocho: 15% soybean flours blended bread shows a significant improvement and equivalent with 100% white wheat bread explains blending improves the nutrient density and benefits to fight against protein /micronutrient deficiency of kocho as a staple food consumer. Limited moisture content of bread is recommended to maintain freshness and improve palatability and was found in the range of 17.5-20%. The lower in moisture and fat content and increased fiber and ash content of kocho bread or with increased kocho substitution is responsible to improve bread stability and storability explains kocho is hydrophilic in nature and the solute computes for the moisture [48,49]. During kocho dough preparation more water was added to obtain the consistent dough in comparison of the wheat bread. Wheat and legume supplemented bread have shorter shelf life due to the growth of microorganisms and rancid flavor development results with increased moisture and fat content due to the hydrophobic property, low water holding capacity and lower fiber content [49,50]. Besides the shelf life wheat: legume supplementation improves the sensorial and nutritional quality [53-55].

Table 2: *The proximate composition of composite bread expressed per 100grams (0KF) 100% white wheat flour, (10FS) 10% kocho, 75%white wheat & 15% soybean flours, (20KF) 20% kocho, 65% white wheat &15%soybean flours, (30KF) 30% kocho, 55% white wheat &15% soybean flours, (40KF) 40% kocho, 45% white wheat &15% soybean flours and (100 KF) 100% kocho flour*

Bread Sample	Crude Protein (%)	Fat (%)	Crude fiber (%)	Ash (%)	Moisture (%)	Carbohydrate (%)	Energy (kcal/100g)
0 KF	10.37±0.1[f]	2.65±0.1[d]	2.73±0.0[d]	2.05±0.1[e]	19.58±0.1[c]	62.62±0.11[b]	300
10 KF	11.87±0.1[a]	3.72±0.2 [a]	3.62±0.0[e]	2.61±0.01[c]	20.07±0.1[a]	58.32±0.21[f]	300
20 KF	11.39±0.3[b]	3.26±0.1 [b]	3.96±0.0[c]	2.59±0.01[f]	20.03±0.12[b]	59.57±0.12[d]	298
30 KF	10.68±0.2[c]	2.98±0.01[c]	4.4±0.1[b]	2.62±0.01[b]	19.45±0.09[d]	60.31±0.06[c]	296
40 KF	10.54±0.2[d]	2.51±0.1[e]	4.96±0.0[a]	2.77±0.01[a]	18.96±0.08[e]	62.41±0.15[b]	299

Soy bean - kocho incorporation is recommended to enhance nutritional quality, sensorial quality, prolong the storability, hardness and reduce springiness of bread attributed to the starch digestion rate, which subsequently releases glucose into the bloodstream at a slower rate [55] and decreases the fat and antoxidant activity [54,57]. The increment of fiber and ash content in the composite bread have health benefits in lowering cholesterol levels and increase bread density. The carbohydrate content excluding the crude fiber of the bread developed from Wheat-Kocho-soybean composite flours was determined by difference ranges 58 – 75 % on dry basis. The carbohydrate content increases with kocho substitution indicates the reserve energy of kocho is starch [2] and decreases due to the presence of soybean explained good source of proteins and fats [25]. Energy denser bread with increased level of carbohydrates particularly fiber helps to alleviate the risk of chronic diseases [25] and improves the functionality (starch swells and forms gel) in the presence of water during baking that contribute to a characteristic texture and bread appearance. The energy contribution ranges 296-300 Kcal/100g decreases with kocho substitution explained the lower in protein and fat reserve in kocho.

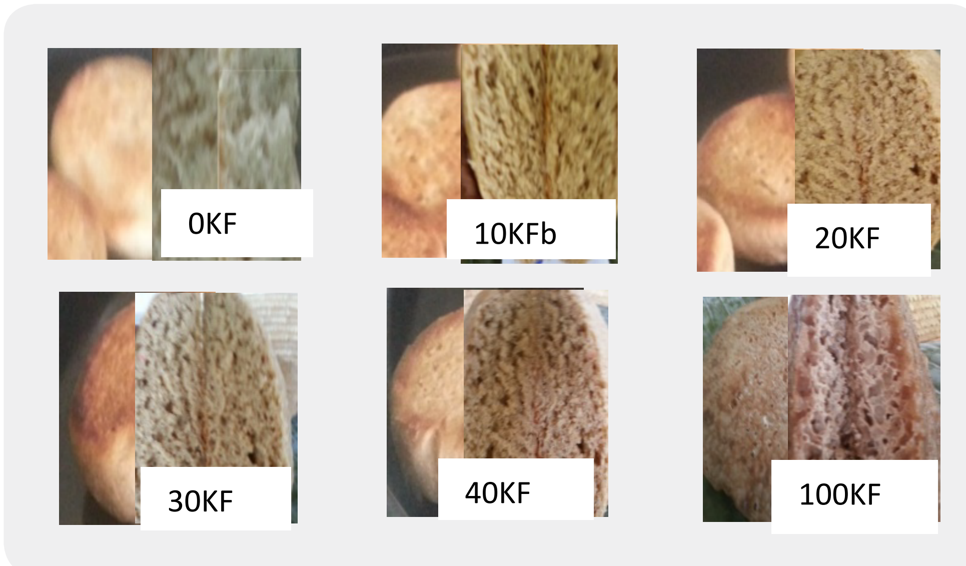

Figure 3: *The overview of bread crust and crumb structure from composite flour; (0KF) 100% white wheat flour, (10 KF) 10% kocho, 75%white wheat & 15% soybean flours, (20KF) 20% kocho, 65% white wheat & 15%soybean flours, (30KF) 30% kocho, 55% white wheat &15% soybean flours, (40KF) 40% kocho, 45% white wheat &15% soybean flours and (100 KF) 100% kocho flour*

Mineral Content

The mineral content of the bread prepared from composite flour (see table 3). The mineral content of 100% kocho bread results higher than 100% white bread. The increased kocho proportion and soybean observed increment in their mineral content. The total ash content from the proximate composition shows increment with increased kocho proportion explains kocho is rich source of minerals; Ca (18 mg/100g), Mg (2.71mg/100g), Fe (2.07mg/100g) and Zn (0.35mg/100g) much higher than white wheat [2,12] and soybean is rich minerals, including potassium, phosphorus, magnesium, calcium and zinc. Addition of soybean improves the mineral content, mineral bioavailability [6] increases the intense of the trace minerals, biochemical functions, necessary for maintaining health life and fight against micronutrient deficiency [3,58].

Table 3: *The mineral composition of composite bread expressed in mg/100gm (0KF) 100% white wheat flour, (10FS) 10% kocho, 75%white wheat & 15% soybean flours, (20KF) 20% kocho, 65% white wheat & 15%soybean flours, (30KF) 30% kocho, 55% white wheat &15% soybean flours, (40KF) 40% kocho, 45% white wheat &15% soybean flours and (100 KF) 100% kocho flour*

Bread Sample	Zn	Fe	Ca	Mg
0 KF	0.28±0.01	1.66±0.02	5.25±0.20	2.49±0.06
10 KF	0.32±0.03	2.53±0.04	10.37±0.17	4.25±0.01
20 KF	0.52±0.01	3.40±0.32	12.07±0.32	4.43±0.2
30 KF	0.41±0.01	3.82±0.05	14.64±0.34	4.30±0.02
40 KF	0.37±0.00	4.13±0.73	15.22±0.15	4.25±0.02
100 KF	0.35±0.00	2.07±0.01	17.58±0.01	2.71±0.00

Conclusion

The finding of this study presents the use of kocho, an anaerobically fermented starchy flour from endogenous tuber crop enset (*Enset ventricosum*) and a staple food to Ethiopia. Kocho is intermediate product which provides high energy from its high starch content, rich source of minerals and lacks protein. Kocho starch is hydrophilic due to its high-water binding capacity and compacted slows heat penetration property during thermal treatment and poor or negligible protein content. The burnet surface and uncooked internal part of the biscuit baked from kocho with and without blending explains kocho is unacceptable for unfermented product baking. Kocho starch heat penetrance is improved through fermentation as the sponginess, functionality, sensorial and nutritional quality of bread was improved up to 40% kocho flour addition. To prevent the prevalence of the protein energy malnutrition in the community where kocho is staple food, blending is important with cereals and legumes to balance the nutrient profile, enhance the likability and functional quality and use as a promising food security crop.

Ethics Approval and Consent to participate

Approved by Hawassa University, college of Health Science

Concept for Publication

All the author in agreement of publication

Computing interests

No computing interests

Funding

No fund was available

Authors' contributions

All authors were equality contributing to the research accumulation and manuscript writeup

Acknowledgement

We thank Hawassa University for allowing us to use the research facility and ethical approval, Sinte Zone and Hawassa Agricultural Research Center for providing the samples and technical assistance for assisting and making conducive working environment.

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