

**EFFECT OF SOYBEAN/CASSAVA FLOUR BLEND  
ON THE PROXIMATE COMPOSITION OF ETHIOPIAN TRADITIONAL  
BREAD PREPARED FROM QUALITY PROTEIN MAIZE**

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## ABSTRACT

The effect of soybean and cassava flour blend on the proximate composition of Ethiopian traditional bread prepared from quality protein maize (QPM) was tested. Normal maize and quality protein maize grains were dried, cleaned and milled using a laboratory-scale mill. Similarly, soybean seeds were roasted, boiled, decorticated, and milled into the required particle size flour sample. Cassava tubers were also peeled, chopped, dried and milled in a similar fashion. Eventually, the soybean and cassava flour samples were blended individually with the quality protein maize flour in three different proportions: 5:95, 10:90 and 15:85, respectively. Normal maize flour was used as a control for the quality protein maize flour. Then bread samples were prepared from the respective composite flours using the sponge and dough method of bread making commonly used in the country. Both the composite flours and the respective bread samples were then analyzed for their proximate compositions: moisture, ash, crude protein, crude fat, crude fibre and carbohydrate. The proximate analyses indicated that there is a significant difference ( $p \leq 0.05$ ) in proximate composition of the plain quality protein maize bread (QPMB) and the soybean- or cassava-supplemented quality protein maize bread samples (SSBs and CSBs). The ash, crude protein, crude fat and crude fibre contents of the soybean-supplemented breads increased with progressive increase in the proportion of soybean flour addition. In the case of the cassava-supplemented bread samples, the highest proximate composition values were recorded for the 10% substitution. Moreover, highest values of carbohydrate, 39.83% and 44.08%, were obtained for the 10% soybean-supplemented breads and 10% cassava-supplemented breads, respectively. The use of these locally available and easily produced grains through blending technology of flours can contribute to combat the widespread protein-energy malnutrition (PEM) in Ethiopia. This approach can also serve as an alternative means for having balanced diet especially for the low-income groups of the most food-insecure people in the country.

**Key words:** Maize, soybean/cassava, bread, proximate composition

## INTRODUCTION

Bread is among the most common foods prepared through fermentation and is a major food for mankind; thus, bread making is one of the oldest processes known [1]. The word *bread* is used to describe the whole range of different bread varieties which may vary in weight, shape, crust hardness, crumb cell structure, softness, colour and eating quality [2].

In Ethiopia, bread is an important staple fermented food, prepared from wheat flour and commonly consumed in both rural and urban areas of the country. Maize, widely grown in Ethiopia, is not usually utilized for bread making except in some parts of the country. However, according to Rocha and Malcata [3], traditional manufacture of bread from maize has been noted to play an important role from both economic and social standpoints.

Maize (*Zea mays*, L.) is the most important cereal in the world after wheat and rice with regard to cultivation areas and total production. Its centre of origin is Mexico and was spread all over the world following the first voyage of Christopher Columbus to America at the end of the fifteenth century [4, 5]. In most developing countries, starchy foodstuffs account for an estimated 70 to 90% of the total calories produced in Tropical Africa, and maize is one of the starchy-staple crops widely grown in this African region. Maize has been more closely linked with economic development of Tropical Africa than any other starchy staple. It became of major importance where foodstuffs had to be transported over considerable distances to feed labourers and populations that were not self-sufficient. In a number of such regions, maize has almost completely replaced traditional starchy foodstuffs such as millet and sorghum. It has almost at one time or another been an export of several Tropical African countries [6].

In Ethiopia, maize is the most important food in terms of total production. It is a staple food crop in some parts of the country, especially in the western and southern parts. It ranks first in both production and yield among the cereals [7]. According to a recent report, the annual production of maize in Ethiopia is 2,743,880.4 metric tons [8]. Furthermore, the Regional Agricultural Trade Expansion Support Programme (RATES) reported that Ethiopia is the third largest producer of maize in eastern and southern Africa following South Africa and Tanzania. It accounts for about 10% of the area and 12% of the production of the region. Maize yield levels are also slightly above the regional average, about 1.7 metric tons/ha compared to 1.5 metric tons/ha for the whole region. In fact, yield of maize is the second highest following South Africa, which is about 2.3 metric tons/ha. RATES was designed by the United States Agency for International Development (USAID) to increase value/volume of agricultural trade within the East and Southern Africa region and between the region and the rest of the world [9].

The nutritional composition of maize grain, as reported by Paliwal & Granados [5], is shown in Table 1. The major chemical component of maize kernel is starch, which

provides up to 73% of the kernel weight. Other carbohydrates are simple sugars present as glucose, sucrose and fructose in amounts that vary from 1 to 3% of the kernel. After starch the next largest chemical component of the kernel is protein. Protein content varies in common varieties from about 8 to 11% of the kernel weight. However, its quality is poor due to low contents of the two essential amino acids, tryptophan and lysine, and the high concentration of leucine, which causes an imbalance of amino acids. Therefore, a new breed of maize called quality protein maize (QPM) with improved contents of these essential amino acids was developed by the International Maize and Wheat Improvement Center (CIMMYT) scientists in partnership with national program researchers [10,11].

Quality Protein Maize (QPM) was developed in the mid-1960's [12]. It is an improved maize variety developed through conventional breeding methods. The biological value of protein in QPM is double than that of normal maize protein. It is, therefore, nutritionally superior over the normal maize. This type of maize contains high amount of two essential amino acids, viz. lysine and tryptophan and low content of the non desirable amino acid (leucine) [13]. The biological value of normal maize protein is equal to about 40% that of milk protein, whereas that of QPM protein is about 90% of that of milk protein. This could almost fulfill the protein needs of malnourished children. Children can meet 90% of their daily protein needs by consuming 175 g of QPM, which is equivalent to 250 g of normal maize. Moreover, studies made by International Maize and Wheat Improvement Centre (CIMMYT) indicated that QPM could contribute to reducing protein deficiencies, particularly in young children. In other studies in Latin America and Ghana, malnourished children were restored to health on controlled diets using QPM [14].

Although there is surplus production of maize in Ethiopia, consumption of maize-based fermented foods, like *injera* and bread, is not widely practiced like that of *teff* and wheat, especially in the big towns and cities. Thus, implementation of composite flour technology is thought to be an appropriate intervention to improve the proximate composition of the traditional bread, thereby showing an alternative way of utilizing maize by humans. The composite flour technology refers to the mixing or blending of the flour of one cereal with that of another cereal or a legume or tuber in different proportions so as to compensate for the nutritional deficiency of the cereal being supplemented. Therefore, based on this theory, it is possible to improve the bread making quality of maize flour by blending it with legumes or tubers that are thought to impart better qualities to the flour.

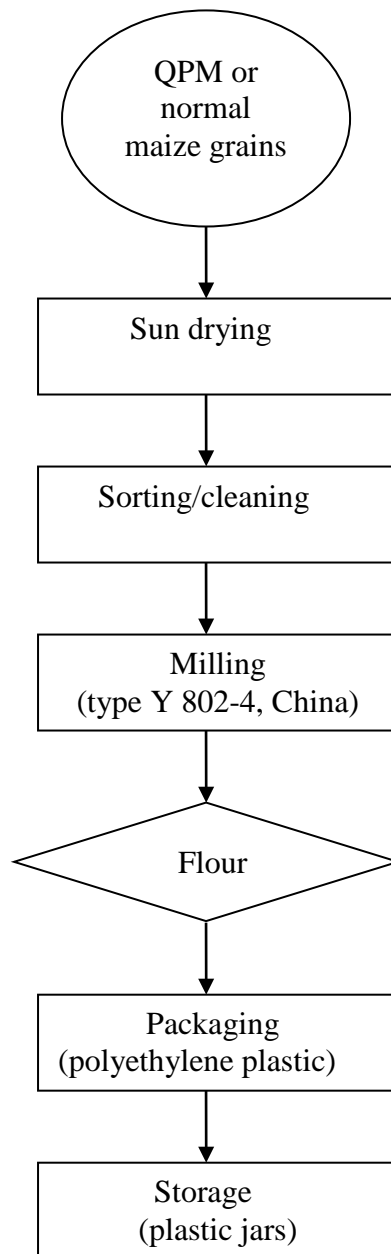
Therefore, as described earlier, QPM has recently been developed and is found to have better protein quality than normal maize. In Ethiopia, however, people are not well aware of the difference between normal maize and the recently introduced variety of maize (QPM) in daily meals like bread. The aim of the present research is, therefore, to study the effect of progressive substitution of QPM flour with soybean and cassava flour on the proximate composition of the bread produced from the composite flour. The study included recipe development and proximate composition

determination of both composite flours and respective bread samples. The outcomes of the study will also be used to generate scientific baseline information for subsequent studies that focus on maize-based value added products improvement and related programmes in the country.

## MATERIALS AND METHODS

### Materials

The raw materials used for preparation of bread were normal maize (*Zea mays*), quality protein maize (QPM), soybean (*Glycin max*) and cassava (*Manihot esculenta*). Normal maize and soybean seeds were purchased from a local market in Addis Ababa, Ethiopia. Quality protein maize was brought from Bako Agricultural Research Centre and cassava from Amaro-Kele, Southern Ethiopia. The grains were thoroughly sorted and extraneous materials removed. The normal maize and quality protein maize flours were prepared using local milling machines. The soybean seeds and the cassava tubers were milled with sample mills (Cyclotec, 1093, Tecator and Grister Convertible Flour and Cereal Mill, Canada). The preparations of the flours from all the three raw materials are indicated in Fig. 1, Fig. 2 and Fig. 3. The flours were placed in plastic jars and stored in the experimental kitchen of the Ethiopian Health & Nutrition Research Institute, where the laboratory analysis was conducted, at room temperature. They were then stored in the laboratory for bread preparation.



**Figure 1: Flow diagram for preparation of maize flour**

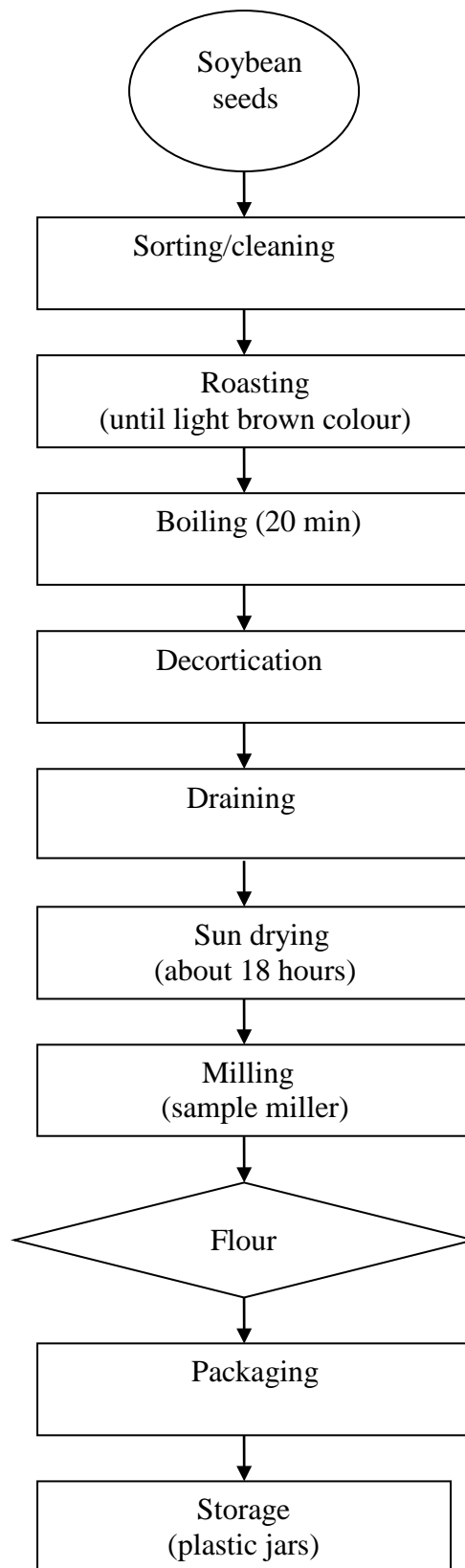
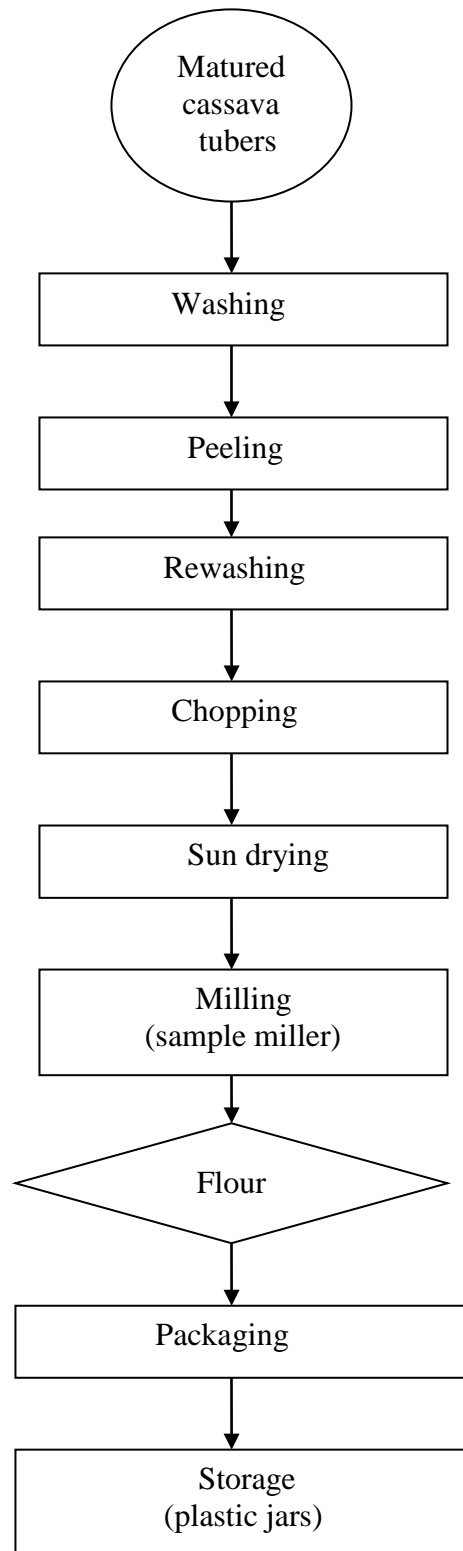


Figure 2: Flow diagram for preparation of soybean flour adapted from: Edema *et al.* [15]



**Figure 3: Flow diagram for preparation of cassava flour adapted from:  
Oluwamukomi *et al.* [16]**



## METHODS

### Sampling and Blend Formulation

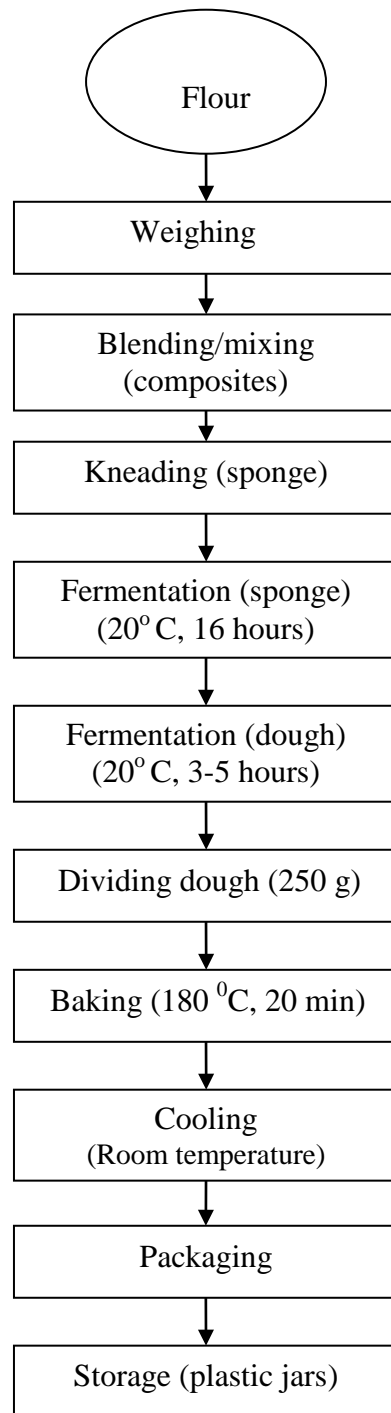
Flour samples from the four raw materials- normal maize, QPM, soybean and cassava- were taken at random and weighed separately. The weighed flour samples (including composite flours of the desired proportions) were transferred into coded plastic bowls. The composite flours (blends) were thoroughly mixed in the respective bowls. A similar procedure was followed while taking flour samples for preparing blends to conduct proximate composition analysis and to prepare breads.

Six different types of flour blends were prepared and normal maize and QPM flour were used as controls. Each of the six blends contains soybean and cassava mixed with QPM flour in the proportions of 95:5, 90:10, and 85:15 (QPM: soybean or QPM: cassava) in all the three proportions. A total of about 500 grams of flour samples from each kind were weighed to prepare bread. Quality protein maize flour (475 g, 450 g and 425 g) was blended with 25 g, 50 g and 75 g supplementation, respectively, for both soybean and cassava composites. The prepared blends and proportions of the composites are presented in Table 2. The normal maize was used to study its difference from quality protein maize.

### Bread Preparation

Six different types of flour blends were prepared as shown in Table 2. Bread samples were prepared from the six different composite flours. The sponge and dough method of bread making commonly practiced in Ethiopian homes was used for making the bread samples. First, the sponge was prepared by mixing 40% of flours with warm water (about 40°C). From the plain maize and composite flours, 200g each were taken into plastic bowls and kneaded with 175 and 225 mL of warm water, respectively, and the sponge was allowed to ferment overnight (about 16 hours). Efforts have been made to use ample amount of water by checking elasticity of the sponge. After 16 hours fermentation of the sponge, the remaining flour (300 g) was mixed with the sponge by adding 175 and 225 mL of warm water for the plain maize and composite flours, respectively. The dough was then fermented for about three hours (second fermentation).

Following the second fermentation, the dough mass was divided into 250g portions and then baked at about 180°C using a household baking machine (Ekosan, 787) for an average of 20 minutes. The internal crumb temperature was about 114±2 °C. The breads were removed from the oven and collected on a traditionally woven grass mat (*sefed*) until they were cool. Then, the breads were transferred to a *mesob* (Ethiopian traditional *injera* and bread storing plate with a lid made from straw) and kept at room temperature. After cooling down, the breads were placed and sealed in plastic bags and stored at room temperature for laboratory analyses. The bread preparation flow chart is shown in Figure 4.



**Figure 4: Flow diagram for preparation of breads**

### Proximate Compositions of Flours and Breads

Proximate compositions of normal maize, QPM flours and those of maize/soybean and maize/cassava composite flours, and bread samples prepared from the respective flours were determined to study the proximate nutritional composition, that is, to compare the nutritional values of the raw materials (flours) and their respective breads. The proximate composition analysis done was for moisture, ash, crude protein, crude fat, crude fibre and carbohydrate content of each sample. All proximate analyses were conducted in duplicates and the respective values were calculated on fresh-weight basis. Official Standard Methods of Analysis were used for proximate analysis of both flour and bread samples [17].

### Statistical Analysis

The data generated from all analyses were collected and analyzed using SPSS software version 13. The obtained results were then interpreted accordingly. The analysis of variance (ANOVA) was conducted to test for least significant differences ( $p \leq 0.05$ ) between bread samples prepared from plain maize and composite flours.

## RESULTS

The proximate compositions of both the plain and composite flours are presented in Table 3. There was a significant variation ( $p < 0.05$ ) in all the proximate parameter among all the treatments tested. The soybean flour had the lowest moisture content while the cassava flour had the highest amount of moisture (6.38% and 11.90%, respectively). However, soybean flour also had the highest ash content among all the treatments while QPM flour had the lowest ash (5.40% and 1.14%, respectively). However, there is a progressive increase in the ash contents of the blended flours with increase in the proportion of soybean flour. It is clear that the increased ash content of the QPM soybean blended flours is due to higher ash content of soybean flour, and this is in good agreement with the work of Olaye *et al.* [18].

Crude protein contents varied from 7.22% for normal maize flour to 35.04% for soybean flour. It is interesting to see that the crude protein content of soybean supplemented QPM flours increased with increase in the percentage of soybean flour supplementation as reported by Edema *et al.* [15]. A similar trend was also observed in the crude protein contents of the bread samples (Table 4) prepared from soybean supplemented QPM flour (SSBs).

The QPM flour sample had higher crude fat and crude fibre contents than normal maize, while the carbohydrates content was somewhat lower. There was an increase in fat and fibre contents of the flour blends from QPM and soybean with a corresponding increase in the proportion of soybean flour supplementation for QPM while there is a decrease in the carbohydrate content.

### Proximate Compositions of Breads

The proximate composition of breads prepared from QPM, normal maize and from soybean and cassava supplemented QPM flours are presented in Table 4. There was a significant variation ( $p < 0.05$ ) in all the proximate parameters among all the treatments tested. The ash, crude protein, fat and crude fibre contents of the soybean-supplemented breads increased as the supplementation of soybean flour increased, while this was not observed in the case of the cassava-supplemented QPM breads. The pattern is nearly similar to that observed in the respective flour samples. Results of the proximate analysis of the cassava-supplemented bread samples showed a decrease in moisture content as supplementation of cassava is increased from 5% to 10%. However, 15% cassava supplemented QPM bread (CSB<sub>15</sub>) showed a slight increment of moisture than the 10% cassava supplemented one (CSB<sub>10</sub>). The ash content of QPMB also increased with progressive increase in proportion of the cassava flour.

## DISCUSSION

### Proximate Compositions of Flours

The mean crude protein and fat contents of normal maize flour were found to be 7.22% and 4.31%, respectively, whereas Paliwal and Granados [5], EHNRI and FAO [19] reported 9.0% and 3.4%, and 8.10% and 4.40%, respectively. Likewise, the crude protein and fat contents of soybean flour were found to be 35.04% and 21.82%, respectively. These values are close to the work conducted by Berk [20]. The mean values of ash, protein, fat, fibre and carbohydrates found in cassava flour are lower than values reported by Oboh and Akindahunsi [21]. Table 3 shows that the improvement made in the proximate compositions of QPM by addition of cassava flour up to 10% was minimal. There are only some improvements in the ash, crude fibre and carbohydrate contents. It was observed that up to 10% cassava supplementation for QPM flour has higher composition values of ash, protein, fat and fibre contents compared to the 15% cassava supplementation. The reduction in the proximate composition of 15% cassava supplemented QPM flour (85% QPMF + 15% CF) might be due to the increased proportion of cassava flour which has low proximate composition.

### Proximate Composition of Breads

The results obtained from proximate analysis of breads prepared from plain maize and QPM soybean blends showed that higher proximate values of the flours resulted in higher proximate values of bread samples. As shown in Tables 3 and 4, a similar trend is observed for cassava supplemented QPM flours and their respective bread samples. The results are similar to those of Oluwamukomi *et al.* [22] for soybean-supplemented maize meal, and Dhingra and Jood [23] for soybean and barley supplemented wheat breads.

The data on proximate composition of breads (Table 4) also showed that as the proportion of soybean flour added increases, there is a decrease in the moisture

content of bread samples. Findings for similar blends exhibit the moisture contents of the bread samples were higher, and the ash content increased progressively with the increase in soybean flour supplementation Oloaye *et al.* [18].

The 10% cassava supplemented QPM bread sample (CSB<sub>10</sub>) has higher crude protein and carbohydrate contents than bread samples prepared from plain QPM flour (QPMB). However, crude fat and crude fibre contents for CSB<sub>10</sub> were found to be lower than those of QPMB. Furthermore, according to EHNRI and FAO [19], the protein, fat and carbohydrate contents for cassava supplemented maize breads were found to be 3.20%, 1.70% and 44.50%.

## CONCLUSION

Nutritionally improved breads could be prepared from up to 15% soybean flour substitution and at 10% cassava flour substitution for QPM flour. Soybean, which is rich in protein and fat, significantly improved the nutritional qualities of the breads prepared from QPM. It was observed from nutritional analyses that QPM has better bread making qualities compared to normal maize. This could obviously be because of the improved protein quality of QPM. Therefore, this study has revealed that supplementation of maize flour, particularly QPM with soybean flour of 10 to 15% and cassava flour at 10%, could improve the nutritional qualities of bread.

Consumption of maize in the form of bread with addition of other legumes or tuber crops (like soybean and cassava) in Ethiopia should be encouraged. Policy makers, universities, research institutes and non-governmental organizations, especially those engaged in food security and nutrition issues, should give due emphasis to this technology.

**Table 1: Proximate composition of maize flour**

Constituent	Value (%)
Moisture	12.0
Ash	1.1
Crude protein	9.0
Crude fat	3.4
Fibre	1.0
Total carbohydrate	74.5

Source: Paliwal & Granados [5]

**Table 2: Proportions of QPM to soybean or cassava in formulation of bread dough**

Types of Flour	Experimental Proportion (g)	Proportion of Supplement (%)
QPMF and SF (SSF <sub>5</sub> )	475 : 25	5
QPMF and SF (SSF <sub>10</sub> )	450 : 50	10
QPMF and SF (SSF <sub>15</sub> )	425 : 75	15
QPMF and CF (CSF <sub>5</sub> )	475 : 25	5
QPMF and CF (CSF <sub>10</sub> )	450 : 50	10
QPMF and CF (CSF <sub>15</sub> )	425 : 75	15

Where:

CF	Cassava flour
SF	Soybean flour
QPMF	Quality protein maize flour
SSF <sub>5</sub>	QPMF supplemented with 5% SF
SSF <sub>10</sub>	QPMF supplemented with 10% SF
SSF <sub>15</sub>	QPMF supplemented with 15% SF
CSF <sub>5</sub>	QPMF supplemented with 5% CF
CSF <sub>10</sub>	QPMF supplemented with 10% SF
CSF <sub>15</sub>	QPMF supplemented with 15% SF

**Table 3: Proximate compositions of plain maize and composite flours**

Flour samples	Composition (%)					
	Moisture	Ash	Crude Protein	Crude Fat	Crude Fibre	Carbohydrate
NMF	8.05±0.04 <sup>d</sup>	1.20±0.04 <sup>a</sup>	7.22±0.41 <sup>b</sup>	4.31±0.02 <sup>d</sup>	2.29±0.01 <sup>b</sup>	76.93±0.17 <sup>g</sup>
QPMF	7.18±0.03 <sup>b</sup>	1.14±0.02 <sup>b</sup>	7.69±0.00 <sup>bc</sup>	4.84±0.00 <sup>f</sup>	2.53±0.05 <sup>b</sup>	76.62±0.04 <sup>eg</sup>
SF	6.38±0.04 <sup>a</sup>	5.40±0.01 <sup>f</sup>	35.04±0.10 <sup>g</sup>	21.82±0.03 <sup>j</sup>	6.75±0.19 <sup>e</sup>	24.61±0.27 <sup>a</sup>
SSF <sub>5</sub>	8.92±0.02 <sup>e</sup>	1.35±0.03 <sup>c</sup>	9.19±0.00 <sup>d</sup>	5.70±0.01 <sup>g</sup>	2.81±0.22 <sup>c</sup>	72.03±0.19 <sup>d</sup>
SSF <sub>10</sub>	7.48±0.01 <sup>c</sup>	1.18±0.03 <sup>b</sup>	10.38±0.38 <sup>e</sup>	6.56±0.01 <sup>h</sup>	3.65±0.07 <sup>d</sup>	70.75±0.53 <sup>c</sup>
SSF <sub>15</sub>	9.54±0.05 <sup>f</sup>	1.56±0.01 <sup>d</sup>	11.50±0.31 <sup>f</sup>	7.19±0.08 <sup>i</sup>	3.71±0.02 <sup>d</sup>	66.50±0.21 <sup>b</sup>
CF	11.90±0.01 <sup>h</sup>	2.91±0.04 <sup>e</sup>	2.39±0.01 <sup>a</sup>	0.59±0.00 <sup>a</sup>	2.25±0.07 <sup>b</sup>	79.96±0.01 <sup>j</sup>
CSF <sub>5</sub>	9.50±0.03 <sup>f</sup>	1.16±0.01 <sup>a</sup>	7.47±0.09 <sup>b</sup>	4.21±0.02 <sup>c</sup>	2.15±0.02 <sup>a</sup>	75.51±0.07 <sup>f</sup>
CSF <sub>10</sub>	7.99±0.01 <sup>d</sup>	1.17±0.02 <sup>a</sup>	7.53±0.03 <sup>b</sup>	4.37±0.01 <sup>c</sup>	3.02±0.12 <sup>c</sup>	75.92±0.10 <sup>eg</sup>
CSF <sub>15</sub>	9.94±0.01 <sup>g</sup>	1.23±0.00 <sup>a</sup>	6.94±0.00 <sup>bh</sup>	3.52±0.00 <sup>b</sup>	2.90±0.02 <sup>c</sup>	75.47±0.02 <sup>f</sup>

All values are means ± SD of duplicates expressed on wet-weight basis. Values followed by different superscripts within columns are significantly different ( $p \leq 0.05$ )



**Table 4: Proximate compositions of breads from plain maize and composite flours**

Bread samples	Composition (%)					
	Moisture	Ash	Crude Protein	Crude Fat	Crude Fibre	Carbohydrates
NMB	40.58±0.48 <sup>a</sup>	0.87±0.01 <sup>d</sup>	5.60±0.04 <sup>d</sup>	2.28±0.02 <sup>e</sup>	1.41±0.14 <sup>a</sup>	49.26±0.19 <sup>g</sup>
QPMB	54.74±0.21 <sup>e</sup>	0.65±0.01 <sup>a</sup>	4.10±0.04 <sup>a</sup>	2.62±0.01 <sup>f</sup>	3.24±0.69 <sup>b</sup>	34.65±0.44 <sup>a</sup>
SSB <sub>5</sub>	53.20±0.04 <sup>d</sup>	0.77±0.03 <sup>c</sup>	5.00±0.00 <sup>c</sup>	2.07±0.01 <sup>d</sup>	1.56±0.01 <sup>a</sup>	37.40±0.07 <sup>b</sup>
SSB <sub>10</sub>	48.06±0.01 <sup>b</sup>	0.94±0.01 <sup>e</sup>	6.10±0.04 <sup>e</sup>	3.36±0.02 <sup>g</sup>	1.71±0.01 <sup>a</sup>	39.83±0.07 <sup>d</sup>
SSB <sub>15</sub>	48.57±0.17 <sup>b</sup>	1.16±0.00 <sup>f</sup>	7.06±0.00 <sup>f</sup>	3.78±0.01 <sup>h</sup>	2.18±0.05 <sup>a</sup>	37.25±0.13 <sup>b</sup>
CSB <sub>5</sub>	53.54±0.36 <sup>d</sup>	0.71±0.01 <sup>b</sup>	4.07±0.07 <sup>a</sup>	1.38±0.02 <sup>a</sup>	1.27±0.00 <sup>a</sup>	39.03±0.30 <sup>c</sup>
CSB <sub>10</sub>	47.29±0.20 <sup>b</sup>	0.87±0.04 <sup>d</sup>	4.41±0.03 <sup>b</sup>	1.94±0.01 <sup>c</sup>	1.41±0.04 <sup>a</sup>	44.08±0.30 <sup>f</sup>
CSB <sub>15</sub>	49.73±0.21 <sup>c</sup>	0.94±0.02 <sup>e</sup>	4.10±0.04 <sup>a</sup>	1.59±0.01 <sup>b</sup>	1.36±0.06 <sup>a</sup>	42.28±0.16 <sup>c</sup>

All values are means ± SD of duplicates expressed on wet weight basis. Values followed by different superscripts within columns are significantly different ( $p \leq 0.05$ )

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