

Effect of Cassava Flour and Plantain Substitution on the Physical, Proximate and Sensory Quality of Trifoliate Yam Stiff Dough

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ABSTRACT

This work determined the physico-chemical properties of trifoliate yam substituted with plantain and cassava flour. Trifoliate yam (*Dioscorea dumetorum*) was substituted with cassava and plantain flours at different proportions. The functional properties, proximate analysis and brown index of the composite flours were determined. The flours were reconstituted into stiff dough, colour and the sensory attributes were determined. Protein contents of flour ranged from 6.38-9.25, crude fibre from 3.45-3.82%, moisture from 5.29-6.46%, fat from 1.38-1.59%, ash from 2.25-2.74% and carbohydrate ranges from 78.5-79.3%. Samples substituted with cassava flours were lighter than those with plantain flours. The brown indices of the flour and stiff dough ranged from 7.55-8.81 and 47.38-49.4 respectively. Sensory evaluation of stiff dough showed no significant differences ($p>0.05$) in appearance, aroma, and in overall acceptability. The sample with 30% plantain was however significantly different ($p<0.05$) to other samples and was preferred to other samples in term of appearance.

INTRODUCTION

Amala is a popular starchy food that is prepared by reconstituting (cooking and stirring with boiling water) fermented or unfermented yam flour (*elubo*), produced traditionally from the processed tuber flesh of white yam (*D. rotundata* or *D. alata*) (Awoyale *et al.*, 2010). It is largely eaten by ethnic Yorubas of South-Western Nigeria. Its popularity as a fufu-like meal is increasing amongst non-ethnic Yoruba consumers in Nigeria including other countries in the Western coast of Africa (Idowu *et al.*, 2013). Akinoso and Abiodun (2013) observed that yam flour is usually substituted with plantain and cassava to produce *amala* in South Western part of Nigeria. Yam is substituted with cassava flour (*Lafun*) which is produced through the submerged fermentation of peeled cassava roots in water (Oyewole and Afolami, 2001). After fermentation, the fermented cassava is subjected to sun-drying and milled in order to obtain the

lafun flour. Plantain (*Musa paradisiaca*) is known as *ogede agbagba* (Yoruba), *ayaba* (Hausa) and *Ogadejioké* (Igbo). Plantain flour is used traditionally for preparation of gruel which is made by stirring the flour with appropriate quantities of boiling water to form a brown thick paste which is known locally as 'amala' (Idowu *et al.*, 1996). Trifoliate yam is among the underutilized yam species with high nutritional value than other yam species. Its properties had not been exploited until recently when the yam is been considered in other products (Abiodun and Akinoso, 2015; Ukpabi *et al.*, 2014). The stiff dough made from trifoliate yam had been reported to be sticky due to its poor binding capacity (Martins *et al.*, 1983; Abiodun and Akinoso, 2015). Hence, improvement on the textural quality of the product could be achieved by addition of cassava flour and plantain flour. Abiodun and Oladapo (2010) and Abiodun *et al.* (2010) studied

the effect of cassava starch and soybean substitution on the properties of trifoliate yam flour and improved dough were reported. This paper present determined the effect of cassava flour and plantain substitution on the physical, proximate and sensory quality of trifoliate yam stiff dough

MATERIALS AND METHODS

Trifoliate yam tubers were obtained from a farm at Iffe, Kogi State while the cassava and plantain were purchased at Ganmo market, Ilorin, Kwara State, Nigeria.

Preparation of trifoliate yam flour

The trifoliate yam was peeled, washed, blanched at 60°C and left in the water overnight. The soaked tubers were drained and dried for 72 hours in the oven (60 °C). After drying completely it was milled using fabricated attrition mill and sieved with a 600µm sized sieve.

Preparation of cassava flour

Cassava tubers were peeled with knife and washed, and cut into smaller sizes. Soaked for 3 days, drained and dried for 72 hours in the oven (60 °C). After drying completely it was milled using fabricated attrition mill and sieved with a 600µm sized sieve.

Preparation of plantain flour

Plantain was peeled, sliced and oven-dried for 72 hours in the oven (60 °C). After drying completely it was milled using fabricated attrition mill and sieved with a 600µm sized sieve.

Preparation of composite flour

Cassava flour and plantain flour were mixed with different percentage of trifoliate yam to form 7 samples of flour for preparation of *amala* (Table 1).

Table 1 composition of flour used for stiff dough

Trifoliate yam%	Plantain flour%	Cassava flour%
100	-	-
90	-	10
80	-	20
70	-	30
90	10	-
80	20	-
70	30	-

Results and Discussion

Effect of cassava and plantain substitution on the proximate composition of trifoliate yam flour

Table 2 showed the values of the proximate composition of substituted flours. Moisture content of the flour ranged from 5.29 to 7.71%. Flour with 30% cassava had higher moisture content which was not significantly different ($p < 0.05$) from 20% cassava flour. Moisture contents of flour with cassava were higher than that of plantain flour. Trifoliate yam had the lowest moisture contents and was significantly different ($p < 0.05$) from all the substituted flours.

The moisture contents of the flours were low and within the recommended value (13%) for flour samples (Codex, 1995). Low moisture contents improves the keeping qualities of flour

The carbohydrate contents of all the samples ranging from 78.5-79.6% agrees with the work of Akinoso and Abiodun (2015) which reported that the dry matter of most root and tuber crops are made up of about 60-90% carbohydrate. Trifoliate yam flour had higher protein contents (9.25%) which was significantly different ($p < 0.05$) from the cassava and plantain substituted flours. The value was similar to the result obtained by Alozie *et al.* (2009) for trifoliate yam flour.

Table 2: Effect of cassava and plantain substitution on the proximate composition of trifoliate yam flour

Samples	Protein %	Fibre %	Carbohydrate %	Moisture %	Fat %	Ash %
100% trifoliate yam	9.25±0.02 ^a	3.45±0.54 ^a	78.5±0.00 ^d	5.29±0.00 ^c	1.38±0.84 ^{abc}	2.25±0.95 ^b
10% cassava	6.46±0.38 ^{bc}	3.76±0.90 ^a	79.60±0.00 ^a	6.68±0.00 ^b	1.30±0.48 ^{bc}	2.43±0.83 ^b
20% cassava	5.95±0.81 ^c	3.93±0.90 ^a	78.50±0.00 ^d	7.55±0.00 ^a	1.17±0.48 ^{cd}	2.67±0.83 ^{ab}
30% cassava	4.45±0.01 ^d	4.08±0.47 ^a	79.4±0.47 ^{ab}	7.71±0.02 ^a	0.98±0.02 ^d	3.21±0.04 ^a
10% plantain	7.51±0.20 ^b	3.46±0.57 ^a	78.8±0.00 ^{cd}	6.65±1.00 ^b	1.40±0.69 ^{abc}	2.53±0.98 ^{ab}
20% plantain	6.69±0.99 ^{bc}	3.68±1.00 ^a	79.1±0.01 ^{bc}	6.33±0.33 ^b	1.47±0.23 ^{ab}	2.60±1.00 ^a
30% plantain	6.38±0.03 ^{bc}	3.82±1.00 ^a	79.3±0.15 ^{ab}	6.46±0.75 ^b	1.59±0.23 ^a	2.74±0.98 ^{ab}

Value with the same superscripts along the column were not significantly different ($p < 0.05$)

The protein contents of plantain substituted flours were higher than the cassava substituted flours except in 10% substituted level. The sample with 30% cassava had the lowest protein content (4.45%). Protein contents of the substituted flours decreased with increase in cassava and plantain flour substitution which may be due to the low protein contents of cassava and plantain. Olosunde *et al.*, (2015) reported 4.72 %

for the protein content of plantain while Alozie *et al.*, (2009) reported 0.74 % protein for cassava. The fibre content ranged from 3.45 to 4.08%. The highest value was in 30 % cassava substitution level while the least was in 100% trifoliate yam. There was no significant difference in the crude fibre content. Fibre is regarded as essential, as it absorbs water and provides roughage for the bowels, assisting intestinal transit.

Fibres aid in digestive processes, and lower the vitamin and enzyme content of the food material (Alaise and Linden, 1999). There were no significant differences ($p < 0.05$) in the ash contents of substituted flours.

The ash content in cassava substituted samples was higher than plantain substituted flour. The higher values of ash contents noted in the cassava added samples could also be of nutritional advantage to consumers. The ash in food refers to the inorganic content residue remaining after the organic matter has been burnt, and it contributes to the nutritional quality of food products. The higher fat content in plantain substituted samples may be attributed to the fat content in plantain as agreed by Olosunde *et al.*, (2015).

Effect of cassava and plantain substitution on the functional properties of trifoliate yam flour

Table 3 shows the effect of cassava and plantain substitution on the functional properties of trifoliate yam flour. Bulk densities ranged from 0.59 to 0.73 g/cm³. The white yam flour had the highest value but was not significantly different ($p < 0.05$) from the trifoliate yam and substituted flour. The density of the flour is important in determining the packaging requirement and material handling (Ezeocha *et al.*, 2011). Udensi *et al.*, (2000) explained that bulk density is a function of particle size and also that increase in bulk density increased the

sink ability of powdered particles which aids wetting by aiding their ability to disperse.

Water absorption capacity ranged from 2.55 to 3.48 ml H₂O/g. Trifoliate yam had higher water absorption capacity (3.48 ml H₂O/g) but was not significantly different ($p < 0.05$) from cassava substituted flours and 10 to 20 % plantain substitution levels. Water absorption capacity decreased in both the cassava and plantain substituted flours while the swelling indices increased till 20 % cassava substituted flour and decline again at 30 % substituted level. The high water absorption capacity was attributed to loose association of starch polymers in the native granule (Ekwu *et al.*, 2005). The differences observed in water absorption capacity of the samples were due to the differences in the degree of association of starch granules in them. Water absorption capacity is the ability of the flour to absorb water and swell for improved consistency in food. It is desirable to improve yield and give body to the food. The reduction in water absorption capacity and swelling index may be due to high moisture contents of the flour and the associative forces within the starch granules during storage (Osundahunsi *et al.*, 2003).

Swelling index ranged from 1.45 to 2.16. There were no significant differences ($p < 0.05$) between samples substituted with 20 and 30 plantain flours in swelling index.

Table 3: Effect of cassava and plantain substitution on the functional properties of trifoliate yam flour

Sample	Bulk density (g/cm ³)	Water absorption capacity (ml H ₂ O/g)	Swelling index
White yam	0.73±0.03 ^a	2.55±0.23 ^b	1.45±0.07 ^d
100% trifoliate yam	0.61±0.02 ^a	3.48±0.04 ^a	1.72±0.04 ^{cd}
10% cassava	0.59±0.10 ^a	3.13±0.18 ^{ab}	1.84±0.05 ^{bc}
20% cassava	0.67±0.08 ^a	2.98±0.16 ^{ab}	1.88±0.06 ^{bc}
30% cassava	0.66±0.04 ^a	3.11±0.17 ^{ab}	1.61±0.13 ^{cd}
10% plantain	0.66±0.04 ^a	3.23±0.07 ^a	1.78±0.03 ^{bc}
20% plantain	0.62±0.02 ^a	3.06±0.10 ^{ab}	2.04±0.04 ^{ab}
30% plantain	0.66±0.01 ^a	2.60±0.13 ^b	2.16±0.08 ^a

Value with the same superscripts along the column were not significantly different (p<0.05)

Trifoliate yam flour substituted with 30% plantain flour had higher swelling index value (2.16) which was significantly different (p<0.05) from cassava substituted flours, white and trifoliate yam flours. Swelling indices of plantain flour increased with increase in substitution level. The least swelling index was in the white yam but was not significantly different (p<0.05) from 100% trifoliate yam flour. The swelling index is an indication of presence of amylase and amylopectin present in the yam flour. Therefore, the higher the swelling index, the higher the associate forces (Ruales *et al.*, 1993). Swelling indicates the degree of exposure of the internal structures of the starch granules to action of water (Ruales *et al.*, 1993).

Effect of cassava and plantain flour substitution on the colour of flour and stiff dough

Table 4 shows the effect of cassava and plantain flour substitution on the colour of flour and stiff dough. Lightness (L*) ranged from 84.55 to 93.09. The flour substituted with 20 % cassava had higher lightness (L*) index but this was

not significantly different (p<0.05) from 100% trifoliate yam, 10 and 30 % cassava and 10 % plantain. This signified that addition of cassava flour to trifoliate yam increased the lightness of the flour. The commercial white yam flour (*elubo*) had the least value (84.55) which was significantly different (p<0.05) from the substituted flour. The commercial white yam flour had higher values in a* (redness) and b* (yellowness) than other flour samples. There are no significant differences (p<0.05) in a* of trifoliate yam and other substituted flours. However, the b* decreased slightly in the cassava substituted flours while an increase was observed in the plantain substituted flours.

There were no significant differences (p<0.05) in the L* values of stiff dough from trifoliate yam and substituted flours but the stiff dough from white yam flour was significantly different (p<0.05) from them. White yam stiff dough also had higher a* (3.80) but was not significantly different (p<0.05) from stiff dough of 100% trifoliate yam and 10% plantain substitution. Higher yellowness (12.92) was observed in stiff dough from 10 % plantain flour but this value was not

significantly different ($p < 0.05$) from other dough except in 20 % cassava substitution. Babajide *et al.*, (2006) reported lower value of 73.46 for L^* of white yam flour and 42.55 for stiff dough 'amala'. However, amala substituted

with sorghum had L^* higher value (50.60). This observation indicated that substitution of yam with other flour could alter the colour components of stiff dough depending on the type and species used.

Table 4: Effect of cassava and plantain flour substitution on the colour of flour and stiff dough

Samples	Flour			'Amala'		
	L^*	a^*	b^*	L^*	a^*	b^*
White yam flour	84.55±0.54 ^d	2.64±0.18 ^a	11.61±0.12 ^a	39.74±4.43 ^b	3.80±0.33 ^a	10.73±1.31 ^{ab}
100% trifoliate yam	92.45±0.60 ^{ab}	1.25±0.31 ^b	7.94±0.12 ^{ef}	52.62±0.52 ^{ab}	3.10±0.25 ^{abc}	12.73±0.25 ^{ab}
10% cassava	92.94±0.23 ^a	1.53±0.13 ^b	8.05±0.10 ^{de}	49.49±3.83 ^a	2.46±0.22 ^{cd}	10.78±0.64 ^{ab}
20% cassava	93.09±0.23 ^a	1.11±0.46 ^b	7.93±0.07 ^{ef}	50.60±2.62 ^a	2.28±0.08 ^d	10.52±0.46 ^b
30% cassava	93.02±0.37 ^a	1.10±0.11 ^b	7.75±0.05 ^f	52.22±1.08 ^a	2.32±0.48 ^d	11.13±1.30 ^{ab}
10% plantain	92.28±0.05 ^{ab}	1.22±0.26 ^b	8.27±0.09 ^{cd}	53.52±1.26 ^a	3.55±0.16 ^{ab}	12.92±0.24 ^a
20% plantain	91.74±0.05 ^{bc}	1.25±0.26 ^b	8.33±0.14 ^c	48.90±2.26 ^a	2.68±0.72 ^{cd}	10.70±0.66 ^{ab}
30% plantain	91.19±0.35 ^c	1.20±0.51 ^b	8.68±0.26 ^b	50.60±0.35 ^a	2.88±0.38 ^{cd}	11.18±0.93 ^{ab}

Value with the same superscripts along the column were not significantly different ($p < 0.05$)

Effect of Cassava and Plantain Flour Substitution on the Brown Index of Flour Stiff Dough

The effects of cassava and plantain flour substitution on the brown index of flour stiff dough are presented in Table 5. The brown indices of flour ranged from 6.91 to 15.45 while that of *amala* ranged from 46.48 to 60.26 respectively. The white yam flour had higher brown index values in flour and *amala*. The flour and *amala* from white yam were significantly different ($P < 0.05$) from other samples. The brown indices of trifoliate yam substituted with cassava and plantain flours increased with increase in substitution level with highest values at 30 % levels. There were significant differences ($P < 0.05$) in the brown indices of *amala* made from other flours. The brown indices observed was similar to the values observed by Abiodun and Akinoso (2015) for trifoliate yam flour

(6.73) and higher than that for white yam flour (18.36). Moreover, Abiodun and Akinoso (2015) reported lower brown index values for *amala* from trifoliate yam (14.63) and white yam (46.72). Variations in these values may be due to the processing methods, cultivar, soil type for cultivation, cultural practices during planting and methods of analyses. Brown index value showed the extent of browning and could be linked to the total phenol content of the flour and dough (Babajide *et al.*, 2006). This is in agreement with the earlier finding of Akissoe *et al.* (2003). Akissoe *et al.*, (2003) and Jimoh *et al.*, (2009) reported that the brown index of the paste increased due to the thermal degradation of the originally colourless complex polyphenols (proanthocyanidins and lignins) to coloured phenols (anthogaridins) during steaming of the paste.

Table 5: Effect of cassava and plantain flour substitution on the brown index of flour stiff dough

Samples	Flour	Amala
White yam flour	15.45±0.16 ^a	60.26±0.06 ^a
Trifoliate yam flour	7.55±0.39 ^e	47.38±0.06 ^f
10% cassava flour	7.05±0.04 ^{ef}	50.51±0.20 ^c
20% cassava flour	6.91±0.07 ^{ef}	49.40±0.12 ^d
30% cassava flour	6.98±0.11 ^{ef}	47.78±0.08 ^e
10% plantain flour	7.72±0.04 ^d	46.48±0.11 ^g
20% plantain flour	8.26±0.05 ^c	51.10±0.13 ^b
30% plantain flour	8.81±0.02 ^b	49.40±0.12 ^d

Value with the same superscripts along the column were not significantly different ($p < 0.05$)

Effect of Cassava and Plantain Substitution on the Sensory Properties of Trifoliate Yam Stiff Dough

Table 6 shows the values of the sensory properties of substituted flours. There were no significant differences ($p < 0.05$) in the aroma and the general acceptability of all the samples. 30%

plantain sample has the highest value for appearance but not significantly different ($p < 0.05$) from other flours except 30 % of cassava substituted amala. 30% cassava substituted amala had the lowest value which could be due to the light colour of cassava flour (*lafun*).

Table 6: Effect of cassava and plantain substitution on the sensory properties of trifoliate yam flour

Samples	Appearance	Texture	Aroma	General acceptability
100% trifoliate yam	6.31±1.89 ^{ab}	5.46±2.44 ^c	5.38±1.76 ^a	5.69±1.84 ^a
10% cassava	5.77±1.64 ^{ab}	6.15±1.63 ^a	5.69±1.32 ^a	5.92±1.50 ^a
20% cassava	6.00±2.04 ^{ab}	6.08±1.85 ^a	5.54±1.33 ^a	6.31±0.95 ^a
30% cassava	4.62±2.26 ^b	5.38±2.02 ^c	5.08±1.85 ^a	5.46±2.05 ^a
10% plantain	6.08±1.38 ^{ab}	5.69±1.03 ^{bc}	5.31±1.32 ^a	5.69±1.25 ^a
20% plantain	6.31±1.93 ^{ab}	5.79±1.75 ^b	5.54±1.76 ^a	5.92±1.55 ^a
30% plantain	6.77±0.93 ^a	5.85±1.77 ^b	5.69±1.65 ^a	5.62±1.39 ^a

Value with the same superscripts along the column were not significantly different ($p < 0.05$)

In Yoruba land, colour of stiff dough 'amala' (dark brown) is one of the important factors that affects the acceptability of the product (Akisoe *et al.*, 2006).

CONCLUSIONS

According to the evaluation done, the colour of the trifoliate yam flour became lighter with increase in cassava flour substitution. The brown index of the white yam flour was higher than substituted flour, but the brown index was reduced with cassava flour substitution while brown index increase in plantain substituted samples. Among the substituted flour the brown index of 20% flour had the higher value. There was no significant differences ($p < 0.05$) in bulk density of all the flour samples, while trifoliate yam had higher water absorption capacity. 30% plantain flour had higher swelling index. Protein is higher in trifoliate yam than all the substituted flour. Substituted flour had low moisture and fat content. Cassava substituted amala was higher in ash content and higher in plantain substituted samples. The colour of trifoliate yam amala with 30% plantain had the most preferred colour. Plantain substituted amala was preferred to cassava substituted amala.

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