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# Effect of cassava starch and defatted soybeans substitution on the properties of trifoliate yam *(Dioscorea dumetorum)* flours

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## ABSTRACT
*Objectives*: To evaluate the effect of cassava starch and defatted soybeans substitution on the textural and nutritional properties of trifoliate yam *(Dioscorea dumetorum*) flours.
*Methodology and results*: Trifoliate yam flour was fortified with cassava starch and defatted soybean flour in range 5% soybeans and 5% starch (TFB) , 10% soybeans and 10% starch (TFC), 10% soybeans and 20% starch (TFD), 15% soybeans and 15% starch (TFE), 15% soybeans and 25% starch (TFF) and 20% soybeans and 20% starch (TFG). Protein content was highest in sample TFG and lowest in unsubstituted trifoliate yam flour (TF) while the fat content increased from 1.03-1.16%. Trifoliate yam flour had higher peak viscosity (219.50RVU) which was significantly different ($p \leq 0.05$) from that of the substituted flour samples. Holding strength values ranged from 97.91 RVU in TFC and 164.67 RVU in TF while breakdown values ranged from 5.43 RVU in TFE and 55.37 RVU in TF. Final viscosity, setback, pasting time and pasting temperature ranged from 13370 RVU in TFC and 247.75 RVU in TF, 19.10 RVU in TFF and 83.07 RVU in TF, 5.09 min in TF and 6.84 min in TFF and 90.19 °C in TF and 92.65 °C in TFD respectively. Sensory evaluation conducted on the dough showed no significant difference ($p \geq 0.05$) in color and odor.
*Conclusion and application of findings*: The nutritional and textural qualities of trifoliate yam flour were improved with the addition of soybeans and cassava starch. Samples with 15% soybeans and 15% cassava starch, or 15% soybeans and 25% cassava starch were more acceptable than the samples containing 5% soybeans and 5% cassava starch, 10% soybeans and 10% starch, 10% soybeans and 20% starch. Processing of trifoliate yam into flour and stiff dough (amala) encourages the use and utilization of the yam in other forms. Fortification with soybean flour makes the food more nutritious thereby alleviating the problem of malnutrition especially in children.
**Key word:** Trifoliate yam, Fortification, Cassava starch, Soybeans flour, Sensory properties

## INTRODUCTION

Yam is one of the staple foods in Nigeria and a crop of economic, social and cultural importance in many tropical countries particularly in West Africa, south Asia and Caribbean (Manuel *et al*., 2005). It is an important source of carbohydrate for about 300 million people through out the world (Ettien *et al*., 2009). Kwashiorkor, a deficiency (inadequate intake of protein) disease associated with carbohydrate is prevalent in yam growing areas (FAO, 1990) and as a result of this; a lot of research work has been carried out to improve the nutritional composition and qualities of yam and its products. The use of defatted, full fat soy flours and cowpea flour to increase the protein contents of yam have been explored (Akingbala *et al.,* 1995; Achi, 1999; Ashaye *et al*., 2001; Jimoh and Olatidoye, 2009). In addition, Abulude and Ojediran (2006) have fortified yam flour with plantain and cassava flour in order to improve its viscosity and texture of yam flour paste. Various species of yam tubers among them are *Dioscorea rotundata, Dioscorea alata* and *Dioscorea cayenensis* have been processed into yam flour (Akissoe *et al*., 2003; Iwuoha, 2004; Ekwu *et al*., 2005; Babajide *et al.,* 2007; Ukpabi & Omodamiro, 2008; Akinwande *et al*., 2008) and results showed that they are good raw materials for yam flour production. However, there is limited work done on the production and utilization of trifoliate yam flour as stiff dough (amala). The reasons could be due to the poor binding capacity of the dough, presence of bitter principle and the hardening process undergone few days after harvesting the tubers (Martins *et al*. 1983; Afoakwa & Sefa-dedeh, 2001, 2002; Medoua *et al*., 2007). The objective of this study was to evaluate the effect of cassava starch and partially defatted soybean flour on the properties of trifoliate yam flour.

## MATERIALS AND METHODS

**Materials**: Freshly harvested trifoliate yam tubers and cassava tubers were obtained from a farm in Ilesa while the soybeans used were purchased from a local market at Ilesa in Osun State.

**Sample preparation:** The yam tubers were peeled, washed, cooked for 30 min and left in the cooking water overnight. They were sun dried for 3 days, milled, sieved and packaged. The cassava starch was prepared according to the method of Akinwande *et al.* (2007) using tap water while the soybeans were prepared using the method of Osho (1991). The partially defatted soybeans and cassava starch were added in varying proportions (TF =Trifoliate flour, TFB = 5% soybeans and 5% starch, TFC = 10% soybeans and 10% starch, TFD = 10% soybeans and 20% starch, TFE = 15% soybeans and 15% starch, TFF = 15% soybeans and 25% starch and TFG = 20% soybeans and 20% starch).

**Analyses:** Proximate analysis was carried out using the method of A.O.A.C (1990) while the pasting properties were carried out using Rapid-visco Analyzer (Newport Scientific 3D for window, 1998).

**Sensory evaluation:** The stiff dough (amala) was prepared by adding flour into 250cm$^3$ of boiled water, stirred thoroughly with a wooden spoon to avoid lumps, and cooked for 15 min to form soft dough. It was removed from the fire and served (Nwaegbute *et al.*, 1995). Sensory analysis of the stiff dough was carried out on the hot (55 ± 2 $^o$C) and cold samples (28 ± 2 $^o$C) with 20 untrained panelists drawn from Yoruba ethnic group among the lecturers of Department of Food Science and Technology, Osun State Polytechnic, Iree, Osun State, who were used to eating stiff dough made from yam flour. A 9-point hedonic scale ranging from 1 (extremely disliked) to 9 (extremely liked) was used to evaluate color, odor, texture and overall acceptability.

**Data analysis:** Proximate analysis was carried out in three triplicates while pasting properties was in duplicate. The data were subjected to Analysis of Variance (ANOVA) ($p \leq 0.05$). Means with significant differences were separated by Turkey test using SPSS 11.0 software.

## RESULTS AND DISCUSSION

The protein content of sample TFG (11.35%) was higher and significantly different ($p \leq 0.05$) from other samples. The protein content increased with increase in soybean substitution (table 1). Also, the fat content of sample TFG was high (1.16%) but was not significantly different ($p > 0.05$) from sample TFC, TFE and TFF due to the high contents of soybean flour. Sample TF had higher value (2.27%) in ash content though not significantly different ($p > 0.05$) from sample TFF and TFG. Ashaye *et al.* (2001) reported an increase in protein content (7.28%) and ash (3.58%) when yam flour was substituted with 40% cowpea flour while Achi (1999) reported an increase in protein content from 3.5% in the control (yam flour) to 19.7% for yam flour fortified with 40% soybeans flour. Carbohydrate content varied and decreased with addition of soybean flour. This was in agreement with the findings of Jimoh and Olatidoye (2009) who reported a decrease in carbohydrate content with increase in soybean flour fortification.

Sample TF (unfortified) form thicker pastes on cooking and had the ability to withstand the heating and shear stress due to the high peak viscosity (219.55 RVU) and holding strength (164.67 RVU).

Also, the final viscosity (247.75 RVU) value of sample TF indicated the ability to form a firm, visco-elastic paste or gel after cooking and cooling owing to re-association of starch molecules (Newport Scientific, 1998). This was in agreement with the finding of Jimoh and Olatidoye (2009) who reported high values for yam flour and decrease in the soybean fortified yam flour samples. Abiodun *et al*. (2010) also reported an increase in peak viscosity of trifoliate yam flour with increase in cassava starch substitution.

**Table 1**: Proximate composition of trifoliate yam flour substituted with cassava starch and defatted soybean flour

| Sample | Protein % | Fat % | Ash % | Fibre % | Moisture % | Carbohydrate % |
|---|---|---|---|---|---|---|
| TF | 8.82d | 1.04c | 2.27a | 1.84b | 9.51a | 75.52b |
| TFB | 10.58c | 1.03c | 2.02c | 1.99a | 9.95a | 74.16c |
| TFC | 10.81bc | 1.10b | 2.09bc | 1.84b | 7.62c | 76.55a |
| TFD | 10.67bc | 1.05bc | 2.14b | 1.69d | 8.66b | 75.79b |
| TFE | 10.91bc | 1.15ab | 2.03c | 1.76c | 8.84b | 75.30b |
| TFF | 11.04ab | 1.12ab | 2.18ab | 1.78c | 8.41b | 75.47b |
| TFG | 11.35a | 1.16a | 2.18ab | 1.78c | 8.81b | 74.73c |
| **LSD** | **0.41** | **0.05** | **0.12** | **0.14** | **0.48** | **0.69** |

Values with the same letter down the column are not significantly different (p > 0.05) from each other

TF =Trifoliate flour, TFB = 5% soybeans and 5% starch, TFC = 10% soybeans and 10% starch, TFD = 10% soybeans and 20% starch, TFE = 15% soybeans and 15% starch, TFF = 15% soybeans and 25% starch and TFG = 20% soybeans and 20% starch

Higher values of 445.3, 164.2, 281.1 and 193.1 RVU were obtained for peak, holding strength, breakdown and final viscosities for *D. rotundata* flour (Akinwande *et al.,* 2004). Babajide *et al.* (2007) observed variation in peak viscosities of six varieties of yam flour ranging from 206.04-242.75 RVU. Variation in values obtained was due to the species of yam used and the amylose-amylopectin ratio of the yam flour. The peak viscosity indicates the water–binding capacity of the flour samples, and is important to the user in order to obtain a useable starch paste (Adeyemi, 1989). High holding strength exhibited by sample TF (unfortified sample) showed that the flour could withstand high heat treatment during processing than the substituted flour sample.

Bhattacharya *et al*. (1999) indicated that high holding strength generally represents low cooking loss and superior eating quality. The substituted flour samples had lower breakdown values which were not significantly different (p > 0.05) from each other. Samples with low breakdown values indicated high stability (Beta *et al*., 2000). Therefore, substituted flour samples were more stable than the trifoliate yam flour. The final viscosities of the flour samples increased on cooling indicating formation of firm gel after cooking. Sample TFD had higher setback value (55.91 RVU) among the substituted flour while sample TFF had the least value (19.10 RVU) indicating minimal amylose retrogradation as the paste is cooled (Bhattacharya *et al*., 1999). Retrogradation of starch paste is of considerable practical significance since it affects textural changes that occur in starchy foods. Setback value is an index of the tendency of the cooked flour to harden on cooling due to amylose retrogradation (Adeyemi, 1989).

Sensory evaluation carried out on the hot (55 ± 2 °C) stiff dough showed no significant difference (p> 0.05) in color, odor, texture and they were all acceptable. The texture of the samples was affected negatively when cool (28 ± 2 °C). Samples with 15% soybeans and 15% cassava starch, or 15% soybeans flour and 25% cassava starch were more acceptable. The stickiness observed in the texture of the dough was as a result of soybean flour fortification coupled with the poor binding properties of trifoliate yam flour. Ashaye *et al*. (2001) observed no significant difference (p > 0.05) in taste, flavor and texture of reconstituted yam flour substituted with 40% cowpea flour. Also, Achi (1999) reported no significant difference (p > 0.05) in taste, flavor, color and overall acceptability with up to 20% soy fortification. Collins and Falasinnu (2006) observed that 10% protein addition of soybeans reduced consistency and increased stickiness, thus lowering the proportion of water in the samples containing soy flour.

**Table 2:** Pasting properties of trifoliate yam flour substituted with varying proportions of cassava starch and defatted soybean flour.

| Sample | Peak Viscosity (RVU) | Holding Strength (RVU) | Breakdown (RVU) | Final Viscosity (RVU) | Setback (RVU) | Pasting Time (min) | Pasting Temperature °C |
|---|---|---|---|---|---|---|---|
| TF | 219.55a | 164.67a | 55.37a | 247.75a | 83.07a | 5.09d | 90.19b |
| TFB | 121.46bc | 112.53bc | 8.93bc | 151.52cd | 38.99c | 6.26b | 91.24b |
| TFC | 105.28cd | 97.91c | 7.40bc | 133.70d | 35.80c | 6.47ab | 91.20b |
| TFD | 133.87b | 121.96b | 11.92b | 177.87b | 55.91b | 6.10bc | 92.65a |
| TFE | 111.84c | 106.42c | 5.43c | 145.78cd | 39.36c | 6.23bc | 90.99b |
| TFF | 134.69b | 125.68b | 8.01bc | 144.77cd | 19.10d | 6.84a | 90.97b |
| TFG | 127.37bc | 118.61b | 8.76bc | 164.32bc | 45.71bc | 6.04c | 91.12b |
| **LSD** | **17.23** | **12.40** | **4.22** | **19.81** | **14.12** | **0.37** | **1.30** |

Values with the same letter down the column are not significantly different ($p > 0.05$) from each other

TF =Trifoliate flour, TFB = 5% soybeans and 5% starch, TFC = 10% soybeans and 10% starch, TFD = 10% soybeans and 20% starch, TFE = 15% soybeans and 15% starch, TFF = 15% soybeans and 25% starch and TFG = 20% soybeans and 20% starch,

**Table 3:** Sensory properties of stiff dough of yam flour substituted with varying proportions of soybean and cassava flour when cold (28 ± 2 °C)

| Sample | Color | Odor | Texture | Overall acceptability |
|---|---|---|---|---|
| TF | 8.65a | 8.55a | 6.70c | 3.10e |
| TFB | 8.05a | 8.55a | 6.85c | 4.55d |
| TFC | 8.15a | 8.35a | 6.85c | 5.90c |
| TFD | 7.95a | 8.35a | 7.55b | 6.60b |
| TFE | 6.85a | 8.85a | 7.75a | 8.55a |
| TFF | 6.75a | 8.85a | 7.60b | 8.75a |
| TFG | 8.00a | 8.60a | 7.65ab | 5.75c |
| LSD | 1.50 | 0.73 | 1.20 | 1.30 |

Values with the same letter down the column are not significantly different ($p > 0.05$) from each other

TF =Trifoliate flour, TFB = 5% soybeans and 5% starch, TFC = 10% soybeans and 10% starch, TFD = 10% soybeans and 20% starch, TFE = 15% soybeans and 15% starch, TFF = 15% soybeans and 25% starch and TFG = 20% soybeans and 20% starch.

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