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Changes in Functional and Pasting Properties of Trifoliate Yam Flour during Storage

***[1]ABIODUN OA; [2]AKINOSO R; [1]OLUOTI O. J**

[1]Osun State Polytechnic, P.M.B. 301, Iree, Osun State, Nigeria
[2]University of Ibadan, Oyo State, Nigeria
Corresponding author e-mail: funmiabiodun2003@yahoo.com

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ABSTRACT: This work aimed at determining the changes in functional and pasting properties of trifoliate yam flour during storage. Freshly harvested trifoliate yam tubers were processed into flour and stored in sealed low density polyethylene polyester for four months. Functional and pasting properties of the flour were evaluated monthly. Moisture contents ranged from 7.49 to 15.30 %. Moisture contents increased with month of storage. Bulk density ranged from 0.58 to 0.69 g/cm^3, water absorption capacity 1.44 to 1.93 ml H_2O/g and swelling index 1.38 to 2.22. The functional properties decreased with length of storage. Flour obtained at the initial period had the least peak viscosity (3180 cP) while the highest value (3338 cP) was at the second month of storage. Storage of trifoliate yam flour improved the holding strength and final viscosities of the flour. Holding strength and final viscosities increased with length of storage. Flour stored at fourth month had higher setback value (1098.5 cP). There were reductions in the pasting time of the flour with storage periods. There were no significant differences (p>0.05) in pasting temperatures of the flours. Storage of trifoliate yam flour for three months is advisable due to high moisture contents which may be detrimental to keeping quality of the flour ©.JASEM

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Introduction: Yam flour is a fine powder made from processing of yam tuber. It is the major ingredient in the making of *Amala* in Nigeria when reconstituted (Akissoe et al., 2003). *Amala* is a traditional thick paste consumed in West Africa and it is prepared from blanched dried yam flour with particular texture (Akissoe et al., 2004). Processing of fresh yam tubers into chips is an activity that is carried out in Nigeria all-round the year regardless of seasonal variations due to high demand by indigenes of the Southwestern and Northwestern Nigeria (Abiala et al., 2011). Processed yam forms are less bulky and less delicate to handle and store, and are less prone to storage losses than in fresh tubers (Onwueme and Charles, 1994).

Ojokoh and Gabriel (2010) observed greater deterioration with regards to nutritive value and microbial load in yam flour than the yam chips during the three months storage due to the wide surface area. Condition of the flour is influenced by the environment during growth and maturation, the degree of microbial invasion, the maturity at harvest, the methods of handling prior to and after crack and mechanical damage or breakage and predispose stored products to microbial invasion (Ojokoh and Gabriel, 2010).

Yam flour from other yam species had been thoroughly studied (Akissoe et al. 2004, 2006; Awoyale et al., 2010) but production of trifoliate yam flour for stiff dough '*amala*' had not been given priority until recently. Abiodun and Akinoso (2014) studied the textural and sensory quality of trifoliate yam flour and stiff dough '*amala*'. Production of flour from trifoliate yam improved the utilization of the yam thereby curb food insecurity in our society. Storage and keeping quality of trifoliate yam flour is of paramount important as these may affect the quality attributes of the flour and the products. Therefore, this paper presents the changes in functional and pasting properties of trifoliate yam flour during storage.

MATERIALS AND METHODS

White trifoliate yam tubers were obtained from a farm at Osogbo, Osun State, Nigeria. The freshly harvested trifoliate yam tubers were washed, drained and peeled. The peeled tubers were steeped in hot water (60 ^oC) for 10 minutes and left in the water for 12 h. The tubers were sliced and dried in the hot air

* *Corresponding author e-mail: funmiabiodun2003@yahoo.com*

oven at 60 ^{o}C for 48 h. The dried chips were milled into flour with hammer mill and sieved with 600 µm mesh sieve (Abiodun et al., 2013). Flour was kept in sealed low density polyethylene polyester and kept at ambient temperature for period of four months starting from March 2013 to July 2013. Moisture content was analyzed using standard method of AOAC (2006), bulk density using Udensi and Okaka (2000) method, water absorption and swelling index using method of Iwuoha (2004). The pasting properties of the flour were determined by RVA (RVA-4, Newport Scientific, Australia) according to Vongsawasdi et al. (2009). The temperature, rainfall and relative humidity for the experimental periods (March to July 2013) were obtained at Nigerian Meteorological Agency, Osogbo, Osun State, Nigeria. The analyses were done in triplicate and data analyzed using SPSS (16.0) software

RESULTS AND DISCUSSION

Moisture contents and functional properties are presented in Table I. Moisture contents ranged from 7.49 to 15.30 %. Moisture content of the fresh flour was lower than the stored flours. The values increased with length of storage. Increase in moisture contents was also observed by Hruskova and Machova (2002) in rice flour during short time storage. Increase in moisture contents may be due to the environmental conditions of storage as shown in Table II. The rainfall and relative humidity increased drastically towards the end of the experimental periods thereby increasing the tendency of the flour to absorb moisture despite the packaging. Hruskova and Machova (2002) reported that flour is a hygroscopic material and its moisture changes with the changes in temperature and humidity of the store environments. The hygroscopic nature of the flour and the permeability of the water vapour transmission through the low density polyethylene polyester may adversely affect the keeping quality of the flour (Navaratne, 2013). The moisture contents observed till third month were still in the range acceptable (13 %) for flours (Codex, 1995: Vongsawasdi et al., 2009). The level of moisture in flour is important mainly for the issue of storage (Al-Dmoor, 2013). The moisture contents of flour stored at the fourth months exceeds this moisture level; therefore the shelf life of the flour is greatly reduced.

Bulk density of the trifoliate yam flours were reduced during storage. The highest value was before storage (0.69 g/cm^3). There was no significant difference ($p>0.05$) in the bulk density of the fresh flour and when stored at a month interval. The fresh flour had ability to weigh more than the stored flours during reconstitution due to the high bulk density. Likewise, water absorption capacity and swelling index were higher in the fresh flour. The values were significantly different ($p<0.05$) from the stored flours. This showed that the starch granules of stored flours were more resistant to swelling than the fresh flour. This corroborates the findings of Katekhong and Charoenrein (2012) for rice flour. The ability of the flours to entrap water and swell were reduced with length of storage. 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. 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 (Osundahunsi et al., 2003; Malomo et al., 2012). Swelling indicates the degree of exposure of the internal structures of the starch granules to action of water (Ruales et al. 1993).

Pasting properties of trifoliate yam flour are shown in Table III. Peak and holding strength viscosities of trifoliate yam flour increased with length of storage. The least peak (3180.5 cP) and holding strength (1919.0 cP) viscosities were in fresh flour. There were no significant differences ($p>0.05$) in the holding strength viscosities of the stored trifoliate yam flours. Fresh rice flour was also reported to have high peak viscosity (247.64 RVU) than the stored (room temperature) rice flour (199.60 RVU) (Kanlayakrit and Maweang, 2013). Breakdown was higher in the fresh flour than the stored flours. There were reductions in breakdown viscosities of the flours with storage time. Decrease in breakdown viscosities during storage indicate that the capacity of the starch granules to rupture was significantly reduced by aging of the starch granules (Noomhorm *et al.* 1997; Zhou *et al.* 2003; Tulyathan and Leeharatanaluk, 2007). The stored flours could withstand shear stress during mixing than the fresh flour. Final viscosities ranged from 2806.5 to 3171.5 cP. The values increased with length of storage which signifies the ability of the stored trifoliate yam flour to form viscous paste after cooking and cooling. The highest setback viscosity (1098.5 cP) was observed at the fourth month. There were no significant differences ($p>0.05$) in the flours stored from two to four months in setback values. Increase in final viscosities and setback values with storage duration may be due to strong and undisrupted granules of the flour after cooking. This was in agreement with the report of Katekhong and Charoenrein (2012) for stored rice flour. The values increased with length of storage which signifies the ability of the stored trifoliate yam flours to form viscous paste after cooking and cooling. The least pasting time (4.60

min) was observed at the fourth month while there were no significant differences ($p>0.05$) in the pasting temperatures of the flours.

Conclusions; Functional and pasting properties of trifoliate yam flours were affected by storage time. The flour had ability to absorb moisture in low density polyethylene polyester. Environmental conditions such as rainfall and relative humidity contributed to increase in moisture contents of the flours during storage. Pasting viscosities were improved while the functional properties decreased with storage time. Trifoliate yam flour could be stored successfully in low density polyethylene polyester for three months.

Table I: Effect of storage on the moisture contents and functional properties of trifoliate yam flour

Storage time (months)	Moisture content (%)	Bulk density (g/cm^3)	Water absorption capacity (ml H_2O/g)	Swelling index
0	7.49 ± 0.37^d	0.69 ± 0.04^a	1.93 ± 0.01^a	2.22 ± 0.01^a
1	9.46 ± 0.32^c	0.68 ± 0.04^a	1.82 ± 0.02^b	1.96 ± 0.03^b
2	10.20 ± 0.05^c	0.64 ± 0.07^b	1.73 ± 0.01^b	1.76 ± 0.01^c
3	12.77 ± 0.52^b	0.59 ± 0.06^c	1.50 ± 0.08^c	1.49 ± 0.02^d
4	15.30 ± 0.42^a	0.58 ± 0.02^c	1.44 ± 0.02^c	1.38 ± 0.01^e

Value with the same superscript down the column are not significantly different ($p<0.05$)

Table 2 Monthly mean temperature, relative humidity and cumulative rainfall for the experimental periods (March-July 2013)

Storagetime (months)	Temperature (°C)	Rainfall (mm)	Humidity (%)
0	33.6	144.8	80
1	32.3	93.4	84
2	31.2	93.2	82
3	30.0	144.3	83
4	28.2	183.2	89

Table 3: Effect of storage on the pasting properties of trifoliate yam flour

Value with the same superscript down the column are not significantly different ($p<0.05$)

Storage time (months)	Peak viscosity (cP)	Holding strength (cP)	Breakdown (cP)	Final viscosity (cP)	Setback (cP)	Pasting time (min)	Pasting Temp (°C)
0	3180.5 ± 3.04^b	1919.0 ± 1.40^b	1261.5 ± 3.04^a	2806.5 ± 2.15^d	887.5 ± 1.34^b	4.67 ± 0.00^a	83.95 ± 0.00^a
1	3309.5 ± 5.44^a	2085.5 ± 1.91^a	1224.0 ± 3.54^{ab}	2972.0 ± 3.39^c	886.5 ± 1.48^b	4.63 ± 0.05^{ab}	84.33 ± 0.14^a
2	3338.0 ± 5.37^a	2143.0 ± 1.09^a	1195.0 ± 5.15^{ab}	3077.0 ± 2.19^b	933.5 ± 1.31^{ab}	4.67 ± 0.00^a	84.20 ± 0.14^a
3	3237.5 ± 2.76^b	2150.0 ± 4.50^a	1087.5 ± 2.63^b	3062.5 ± 3.04^b	912.5 ± 3.54^{ab}	4.67 ± 0.00^a	83.93 ± 0.04^a
4	3298.5 ± 2.12^a	2073.0 ± 4.24^a	1225.5 ± 3.36^{ab}	3171.5 ± 2.19^a	1098.5 ± 2.62^a	4.60 ± 0.00^b	83.65 ± 0.57^a

Value with the same superscript down the column are not significantly different ($p<0.05$)

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