Short Research Article

ANTINUTRITIONAL PROPERTIES OF YAM FLOUR TREATED WITH CHEMICAL PRESERVATIVES DURING 6 MONTHS OF STORAGE IN RELATION TO PACKAGING MATERIALS

Abstract

Antinutritional properties of yam flour treated with chemical preservatives during six months of storage were carried out. Yam samples were purchased from *wurukum* market, processed to obtain yam flour treated with chemical preservatives and packaged in plastic and low density polyethylene. About 100 grams of each of the different samples were separated in to five portions. First portion (sample A) was treated in a water bath with 250 ml of water with 0.5% of sodium metabisulphite for 15 minutes, drained and dried in an authomated drier at about 70^{o}C until dried to brittleness, Second portion (Sample B) was immersed in a solution of 0.5% Ascorbic acid for 15 minutes respectively, Third portion(Sample C) was immersed in a solution of 0.5% of Citric acid for 15 minutes, Fourth portion (Sample D) was immersed in a solution of 0.5% of Ascorbic and Citric Acid ,Fifth portion was blanched at 70^{o}C for 5 minutes respectively. The yam slices were dried to brittleness and milled separately with a laboratory hammer mill and sieved using a 250 um mesh to obtain yam flour referred to as high –quality yam flour . The flour samples were analyzed for antinutritional using standard laboratory procedures. The antinutritional factors in the high-quality yam flour were significantly different ($p \leq 0.05$) from each other in terms of pretreatment but there was no significant difference in packaging material across storage. Antinutritionals factors of yam flour samples decreased as storage progressed. The alkaloid contents of the different yam flour samples ranged from 0.17mg/100 g before storage to 0.39mg/100 g two months after storage, The Tannin contents of the different yam flour samples ranged from 0.32–0.68 mg/100 g (month 0), 0.04–0.64 mg/100 g (month 2), 0.31–0.58 mg/100 g (month 4), and 0.28–0.52mg/100 g (month 6) and The saponnin contents of the different yam flour samples ranged from 0.21–0.39 mg/100 g (month 0), 0.20–0.34 mg/100 g (month 2), 0.19–0.35 mg/100 g (month 4), and 0.21–0.32 mg/100 g (month 6).The antinutritional factors in the treated and untreated yam flour samples were significantly ($p < .05$) affected by pretreatment,storage and packaging materials. Chemical preservatives used in yam processing makes treated yam flour safe for consumption after six months of storage.

Keywords: Antinutritional composition,Yam flour, Chemical preservatives and Packaging materials.

Introduction

Yams (*Dioscorea spp*) constitute an important staple food in tropical and sub-tropical regions of the world. Yam tubers have high carbohydrate content (Kouassi *et al*., 2009) and are also sources of protein, fats, vitamins and minerals for many people.

Over 600 species of yam out of which only few are cultivated for food have been reported by IITA, (2006). Bhandari *et al.,* (2003) reported that there are several different edible yam species and available in different tropical regions, which differ in their chemical composition and nutritional importance. Many species and cultivars of edible yams are not consumed raw because of itchiness, bitterness,or toxicity (okwu and ndu,2006).

So far the antinutrient compositions of the economically important species of yam have not been widely reported. Antinutritional factors when present in a food system lower the bioavailability of protein and minerals (Udensi,and onuoha 2010).

Some researchers (okeola and machuka,2001: Ajibade *et al.,* 2005,Fasoyiro *et al,*2006) identified the presence of some antinutritional factors in the seed of African Yam Bean. These are alkaloids,flavonoids, saponins ,trypsin inhibitor, phytate,tannin and oxalate, while Nwinuka *et al*.(1997) identified some gassy factors like sucrose, raffinose and stachyose. Betche *et al*.(2005), identified amylase as the notable anti – nutrients in African Yam Bean. These anti-nutritional factors can be reduced by using efficient processing techniques and proper cooking (Adewale et al.2013).

Materials and Methods

Yam tubers of specie *Dioscorea rotundata* used during cause of this research work was bought in Wurukum market, Makurdi area of Benue State. The yam tubers were selected by their shape and size without any external damage or blemish. Untreated yam flour and high quality ponded yam flour (HQPYF) was bought from a store and from Wadata market. All samples were packaged in sterile bags and transported to the laboratory of the university for processing.

Processing of Yam Flour

High- quality yam flour was processed according to the procedures described by (Omohimi *et al*., 2019). The harvested tubers of yam were thoroughly washed to remove sand and other dirt particles. The washed tubers were peeled using a stainless steel knife and sliced into 1 mm pieces using stainless steel vegetable slicer. The slices were washed in distilled water and divided in five equal portions, each of them were weighed using an electronic scale. About 100 grams of each of the different samples were separated in to five portions. First portion (sample A) was treated in a water bath with 250 ml of water with 0.5% of sodium metabisulphite for 15 minutes, drained and dried in an automated drier at about 70 ^{o}C until dried to brittleness, Second portion (Sample B) was immersed in a solution of 0.5% Ascorbic acid for 15 minutes respectively. Third, portion (Sample C) was immersed in a solution of 0.5% of Citric acid for 15 minutes. Fourth, portion (Sample D) was immersed in a solution of 0.5% of Ascorbic and Citric Acid.The fifth portion was blanched at 70 ^{o}C for 5 minutes respectively. The yam slices were dried to brittleness and milled separately with a laboratory hammer mill and sieved using a 250 um mesh to obtain yam flour referred to as high –quality yam flour. The flour samples were analysed and packaged in airtight plastic and low density polyethylene materials and stored for further analysis.

Test for alkaloids:

Tannin, Saponin and Alkaloid was conducted on both untreated and treated flour samples. Phyto-chemical screenings was done using method of (AOAC, 2000).

Statistical analysis

The means of the data that was obtained for treated, untreated and market purchased yam flour were subjected to analysis of variance (ANOVA).

RESULTS AND DISCUSSION

Table 1: Alkaloids Content of Treated and Untreated Yam Flour Samples (Main effect)

Packaging material	Alkaloids (%)			
	0	2	4	6
Plastic	0.25^{a}	0.36^{a}	0.27^{a}	0.36^{a}
LDPE	0.35^{a}	0.39^{a}	0.35^{a}	0.38^{a}

FLSD{0.05}				
P-value				
Treatments				
A	0.21^{e}	0.37^{e}	0.27^{f}	0.26^{e}
B	0.18^{f}	0.39^{d}	0.30^{e}	0.28^{de}
C	0.15^{h}	0.43^{b}	0.26^{g}	0.31^{cd}
D	0.29^{c}	0.36^{f}	0.33^{d}	0.30^{b}
E	0.38^{a}	0.21^{g}	0.20^{h}	0.19^{f}
F	0.17^{g}	0.45^{a}	0.38^{b}	0.36^{b}
G	0.36^{b}	0.41^{c}	0.40^{a}	0.38^{a}
H	0.24^{d}	0.40^{c}	0.35^{c}	0.33^{cd}
FLSD				
P-VALUE{0.05}				

Values are means of duplicate sample ± SD. Values with different superscript in the same column are significantly different at ($p<0.05$).

Key:
A= Flour sample treated with 0.5% of Sodium metabisulphite.
B = Flour sample treated with 0.5% of Ascorbic Acid
C= Flour sample treated with 0.5% of Citric Acid
D=Flour sample treated with 0.5% of Ascorbic and Citric Acid.
E= Flour sample bought from a local market exposed
F= Blanched flour samples
G= Flour samples neither treated or Blanched
H= High quality pounded yam flour bought from a store

Table 2: Alkaloids Content of Treated and Untreated Yam Flour Samples (Interactive effect)

	Alkaloids (%)			
Packaging materials	0	2	4	6
Plastic				
A	0.21^{e}	0.36^{fg}	0.25^{j}	0.25^{ef}
B	0.18^{f}	6.36^{fe}	0.28^{i}	0.26^{ef}
C	0.15^{h}	0.43^{c}	0.20^{k}	0.30^{cde}
D	0.29^{c}	0.35^{g}	0.32^{g}	0.30^{cde}

E	0.38^{a}	0.21^{i}	0.20^{k}	0.18^{g}
F	0.17^{g}	0.45^{b}	0.35^{e}	0.35^{bc}
G	0.36^{b}	0.39^{d}	0.38^{d}	0.32^{a}
H	0.24^{d}	0.35^{g}	0.35^{j}	0.25^{bc}
LDPE				
A	0.21^{e}	0.39^{d}	0.29^{h}	0.28^{de}
B	0.18^{f}	0.42^{c}	0.32^{g}	0.30^{cde}
C	0.15^{h}	0.43^{c}	0.33^{f}	0.32^{cde}
D	0.29^{c}	0.37^{e}	0.35^{e}	0.42^{a}
E	0.38^{a}	0.22^{h}	0.20^{k}	0.20^{fg}
F	0.17^{g}	0.45^{b}	0.42^{c}	0.37^{ab}
G	0.36^{b}	0.43^{c}	0.43^{b}	0.36^{a}
H	0.24^{d}	0.46^{a}	0.5^{a}	0.32^{bcd}

Values are means of duplicate sample ± SD. Values with different superscript in the same column are significantly different at ($p<0.05$).

Key:

A= Flour sample treated with 0.5% of Sodium metabisulphite.
B = Flour sample treated with 0.5% of Ascorbic Acid
C= Flour sample treated with 0.5% of Citric Acid
D=Flour sample treated with 0.5% of Ascorbic and Citric Acid.
E= Flour sample bought from a local market exposed
F= Blanched flour samples
G= Flour samples neither treated or Blanched
H= High quality pounded yam flour bought from a store

Table 3: Saponin Content of Treated and Untreated Yam Flour Samples (Main effect)

Packaging materials	Saponin (%)			
	0	2	4	6
Plastic	0.25^{a}	0.29^{a}	0.39^{a}	0.24^{a}
LDPE	0.25^{a}	0.31^{a}	0.28^{a}	0.26^{a}
FLSD				
P-VALUE{0.05}				
Treatments				
A	0.24^{d}	0.30^{d}	0.31^{a}	0.21^{d}
B	0.26^{c}	0.26^{e}	0.23^{a}	0.22^{d}
C	0.22^{e}	0.39^{a}	0.35^{a}	0.28^{b}
D	0.24^{d}	0.26^{f}	0.22^{a}	0.25^{c}
E	0.22^{e}	0.24^{g}	0.54^{a}	0.21^{d}
F	0.20^{f}	0.33^{c}	0.19^{a}	0.22^{d}
G	0.34^{a}	0.33^{c}	0.31^{a}	0.30^{a}
H	0.32^{b}	0.36^{b}	0.33^{a}	0.32^{a}

Values are means of duplicate sample ± SD. Values with different superscript in the same column are significantly different at ($p<0.05$).

Key:
A= Flour sample treated with 0.5% of Sodium metabisulphite.
B = Flour sample treated with 0.5% of Ascorbic Acid
C= Flour sample treated with 0.5% of Citric Acid
D=Flour sample treated with 0.5% of Ascorbic and Citric Acid.
E= Flour sample bought from a local market exposed
F= Blanched flour samples
G= Flour samples neither treated or Blanched
H= High quality pounded yam flour bought from a store

Table 4: Saponin Content of Treated and Untreated Yam Flour Samples (Interactive effect saponin)

Packaging materials	0	**Saponin (%)** 2	4	6
Plastic				
A	0.24^{d}	0.28^{g}	0.31^{b}	6.18^{i}
B	0.26^{c}	0.26^{h}	0.22^{b}	0.21^{gh}
C	0.22^{e}	0.38^{b}	0.35^{b}	0.21^{gh}
D	0.24^{d}	0.24^{i}	0.18^{b}	0.27^{d}
E	0.22^{e}	0.18^{j}	0.184^{a}	0.20^{h}
F	0.20^{f}	0.36^{c}	0.18^{b}	0.28^{f}
G	0.34^{a}	0.32^{e}	0.30^{b}	0.25^{bc}
H	0.32^{b}	0.36^{c}	0.34^{b}	0.30^{a}
LDPE				
A	0.24^{d}	0.32^{e}	0.31^{b}	0.25^{e}
B	0.26^{c}	0.27^{g}	0.25^{b}	0.23^{ef}
C	0.22^{e}	0.40^{a}	0.35^{b}	0.36^{a}
D	0.24^{d}	0.28^{g}	0.26^{b}	0.22^{fg}
E	0.22^{e}	0.24^{i}	0.23^{b}	0.22^{fg}
F	0.20^{f}	0.30^{f}	0.20^{b}	0.22^{fg}
G	0.34^{a}	0.34^{d}	0.32^{b}	0.32^{b}
H	0.32^{b}	0.36^{c}	0.33^{b}	0.30^{c}

Values are means of duplicate sample ± SD. Values with different superscript in the same column are significantly different at ($p<0.05$).

Key:
A= Flour sample treated with 0.5% of Sodium metabisulphite.
B = Flour sample treated with 0.5% of Ascorbic Acid
C= Flour sample treated with 0.5% of Citric Acid
D=Flour sample treated with 0.5% of Ascorbic and Citric Acid.
E= Flour sample bought from a local market exposed
F= Blanched flour samples
G= Flour samples neither treated or Blanched
H= High quality pounded yam flour bought from a store

Table 5: Tannin content of Treated and Untreated Yam flour samples (Main Effect)

	Tannin (%)			
PACKAGING MATERIALS	0	2	4	6
PLASTIC	0.51^{a}	0.45a	0.45a	0.38a
POLYTENE	0.51^{a}	0.56a	0.53a	0.47a
FLSD VALUE{0.0}				
TREATMENT				
A	0.52^{d}	0.32^{g}	0.47^{cd}	0.41^{c}
B	0.47^{e}	0.41^{f}	0.47^{d}	0.40^{c}
C	0.43^{f}	0.63^{b}	0.60^{a}	0.54^{a}
D	0.64^{b}	0.60^{c}	0.55^{b}	0.36^{ds}
E	0.43^{f}	0.66^{a}	0.56^{b}	0.51^{b}
F	0.40^{g}	0.46^{e}	0.43^{e}	0.39^{c}
G	0.68^{a}	0.51^{d}	0.49^{c}	0.40^{c}
H	0.56^{c}	0.46^{e}	0.38^{f}	0.39^{c}

Values are means of duplicate sample ± SD. Values with different superscript in the same column are significantly different at ($p<0.05$).

Key:
A= Flour sample treated with 0.5% of Sodium metabisulphite.
B = Flour sample treated with 0.5% of Ascorbic Acid
C= Flour sample treated with 0.5% of Citric Acid
D=Flour sample treated with 0.5% of Ascorbic and Citric Acid.
E= Flour sample bought from a local market exposed
F= Blanched flour samples
G= Flour samples neither treated or Blanched
H= High quality pounded yam flour bought from a store

Table 6: Tannin Content of Treated and Untreated Yam Flour samples (Interactive Effect)

Packaging materials	**Tannin**			
	0	2	4	6
Plastic				
A	0.32d	0.04^{j}	0.46^{gh}	0.34^{j}
B	0.47^{e}	0.35^{i}	0.47^{fg}	0.36^{hi}
C	0.43^{f}	0.62^{d}	0.58^{c}	0.47^{de}
D	0.64^{b}	0.58^{e}	0.50^{e}	0.28^{k}
E	0.43^{f}	0.64^{bc}	0.47^{f}	0.52^{b}
F	0.40^{g}	0.48^{g}	0.42^{i}	0.35^{hij}
G	0.68^{a}	0.48^{g}	0.46^{gh}	0.33^{j}
H	0.56^{c}	0.45^{h}	0.31^{j}	0.22^{g}
LDPE				
A	0.52^{d}	0.61^{d}	0.49^{ef}	0.48^{cd}
B	0.47^{e}	0.47^{g}	0.45^{gh}	0.44^{ef}
C	0.43^{f}	0.65^{b}	0.63^{b}	0.61^{a}
D	0.64^{b}	0.62^{d}	0.60^{b}	0.45^{ef}
E	0.43^{f}	0.68^{a}	0.65^{a}	0.50^{bc}
F	0.40^{g}	0.45^{h}	0.44^{hi}	0.43^{fg}
G	0.68^{a}	0.54^{f}	0.52^{d}	0.47^{de}
H	0.56^{c}	0.48^{g}	0.46^{gh}	0.37^{h}

Values are means of duplicate sample ± SD. Values with different superscript in the same column are significantly different at ($p<0.05$).

Key:

A= Flour sample treated with 0.5% of Sodium metabisulphite.
B = Flour sample treated with 0.5% of Ascorbic Acid
C= Flour sample treated with 0.5% of Citric Acid
D=Flour sample treated with 0.5% of Ascorbic and Citric Acid.
E= Flour sample bought from a local market exposed
F= Blanched flour samples
G= Flour samples neither treated or Blanched
H= High quality pounded yam flour bought from a store

The Alkaloid contents of the different yam flour samples ranged from 0.17mg/100 g before storage to 0.39mg/100 g two months after storage as shown in Table 1 The Alkaloid contents of flour samples decreased as storage progressed from month 0 to month 6, while the other samples varied haphazardly. The Alkaloid content was significant different ($p < 0.05$) from each other. The Table 1 on the main effect of treatment, packaging materials and storage period indicated that there was no significant differences ($p > 0.05$) in Alkaloid content in different packaging materials during storage; but showed significant differences ($p \leq 0.05$) in the treatment and storage period

The presence of antinutritional factors may adversely affect the nutritive value of foods (McAnuff *et al.*,2005). The availability of alkaloids in the tubers of *Dioscoresa species* indicates that yam tubers should not be eaten raw. The level of alkaloids of this study are lower compared to studies on different yam varaieties by Okwu and Ndu (2006). Alkaloids are toxic and can cause a wide range of physiological changes in the body when consumed (Awa and Chinedum,2015). However,simple processing such as cooking removes the alkaloid present in most cultivated species of yams(Cemaluk,Daniel and Nkiru, 2014).

The saponnin contents of the different yam flour samples ranged from 0.21–0.39 mg/100 g (month 0), 0.20–0.34 mg/100 g (month 2), 0.19–0.35 mg/100 g (month 4), and 0.21–0.32 mg/100 g (month 6) as shown in Table 3 The saponnin contents of flour samples decreased as storage progressed from month 0 to month 6, Saponnin content of flour samples was ranged from 0.18 mg/100 g – 0.36 mg/100 g while the other samples varied haphazardly. The Saponnin content was significant different ($p < 0.05$) from each other. The Table 3 on the main effect of treatment, packaging materials and storage period indicated that there was no significant differences in saponnin content in different packaging materials during storage; but showed significant differences ($p \leq 0.05$) in the treatment and storage period

Saponins are considered important due to their toxicity in yams (Okwu and Ndu,2006). This toxic metabolite occurs in varying concentration in yam tubers. The saponin contents of yam in this research was lower than 2.98-19.5 mg/100 g reported by Okwu and Ndu (2006).

High levels of saponin in yam are responsible for its bitter characteristic taste. Saponins natural tendency to ward off microbes makes them good candidates for treating fungal infections (Okwu and Ndu,2006)

This compounds have been reported to serve as natural antibiotics, which help the body to fight infections and microbial invassions (Sodipo *et al.*,2000).

Tannin

The Tannin contents of the different yam flour samples ranged from 0.32–0.68 mg/100 g (month 0), 0.04–0.64 mg/100 g (month 2), 0.31–0.58 mg/100 g (month 4), and 0.28–0.52mg/100 g (month 6) as shown in Table 4, 3 respectively, The Tannin contents of flour samples decreased as storage progressed from month 0 to month 6, while the other samples varied haphazardly. The Tannin content was significant different ($p < 0.05$) from each other. The Table 4 on the main effect of treatment, packaging materials and storage period indicated that there was no significant differences ($p > 0.05$) in tannin content in different packaging materials during storage; but showed significant differences ($p \leq 0.05$) in the treatment and storage period

The tannin concentration in flour samples was relatively lower when compared with values reported for D. *rotundata* reported by Uka(1983).
The toxicity effects of the tannin might not be significant since the total acceptable tannic acid daily intake for a man is 560 mg per day Anonymous (1973), the tannin content of flour samples of this study are very low compared to its critical toxicity effect. Thus, tannin contents of the current study had no significant health hazard even at raw level.
The bitter characteristic of D. *dumetorum* may be due to the high level of tannin found in it. The trace quantities of tannin available in yam tubers act as a repellent against rot in yams (Okwu and Ndu, 2006).However, antinutrient in general, could be minimized as a result of

cooking, soaking and drying FAO(1999).

Afiukwa *et al.,* (2013) reported that protein digestability and palatability are reduced when tannin forms complexes with protein. However, their contents in food are known to reduce through cooking (Lewu *et al*.,2010).

Conclusion.

Antinutritional properties of flour samples treated with chemical preservatives reduced as storage progressed.The presence of antinutritional factors can adversely affect the nutritive value of foods. Antinutritional components of yam such as Tannins, Alkaloids and saponins can be inactivated or reduced through heat treatments such as Blanching or cooking before consumption.

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