

Nutritional Quality Evaluation of Stored Onion (*Allium cepa* L.) Powder in Transparent and Amber Coloured Jars

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ABSTRACT

This study investigated the proximate compositions, microbial counts and total polyphenols content of onion powder stored at ambient temperature for six months in transparent and amber coloured jars. Standard methods of Association of Analytical Chemists (AOAC), American Public Health Association (APHA) were used to evaluate the proximate composition and microbial count of the powder while the Folin-Ciocalteu method was used to assess total polyphenols during and after storage. There were significant ($p < 0.05$) differences in the total polyphenol (TP) contents and proximate composition of onion powder stored in amber and transparent jars. Total polyphenol contents of the onion powder decreased from an initial value of 14.60 ± 1.08 mg/g GAE to a final value of 5.92 ± 0.76 mg/g GAE in the amber coloured jar after storage while a final value of 1.64 ± 0.78 (mg/g) GAE was evaluated after storage in the transparent jar. From proximate compositions, only crude protein, fibre and moisture contents increased during and after storage in both storage jars. There was more retention of proximate parameters in the content of amber storage jar during and after storage. Microbial colony counts in onion powder in the amber jars were fewer than in the transparent jars during and after storage. To minimize wastage of onion during glut season, onion should be made into powder form and better stored in amber coloured material for better retention of nutritional qualities prior to use at home or industry.

Keywords: Onion, Powder, Nutritional Quality, Storage

INTRODUCTION

Onion (*Allium cepa* L.) which belongs to the lily family *Amaryllidaceae* is a herbaceous and highly perishable crop whose post-harvest value addition can be enhanced through dehydration (Jayeeta, *et al.*, 2012). Common varieties of onion include red Tropicana, Bombay red (brown onion), white onion among others (Nuutila *et al.*, 2003). Onion (*Allium cepa*L.) has been revered through the ages not only for its culinary uses but also for its therapeutic properties. Nigeria is the largest producer in West Africa with a total production of slightly above 1.1 million tonnes; however, more than 50% loss occurred during storage of fresh onion (FAO, 2015). About 50% of onions produced in 2010 under irrigation and rain fed cultivation in Nigeria were from Kano State, Nigeria (Muhammad, 2018). Remarkably known for its aroma, taste and lachrymatory effects, onion plays significant role in the industries as constituents for moth repellent, beverages,

expectorants as well as condiment in biscuits (Sharma *et al.*, 2005). Studies have shown that bioactive molecules such as phenolic compounds in onions contribute in lowering bone resorption, and in prevention of degenerative diseases due to some significant number of polyphenols and potential antioxidant activity (Nuutila *et al.*, 2003). Onions have been evaluated for considerable nutritional value such as lipid, protein, reducing sugar, iron, calcium, vitamin C (Anju *et al.*, 2010), phenolic contents as well as antioxidant activity (Cheng, *et al.*, 2013).

Dehydration or drying of foods can be described as any process that involves thermal removal of volatile substances to obtain a dry solid (Anju, 2010). Due to a high demand for onions especially in Europe, dehydrated onions in powdered form, canned onion and onion pickles have gained recognition in world trade (Srinivasa and Sabramanyam, 1999). Onion dehydration is

aimed at limiting the moisture content in the food matrix to prevent microbial spoilage of its nutritional and organoleptic properties (Araya-Farias and Ratti, 2009), to increase its shelf life, improve quality, simplify handling, storage and transportation as well as making condiments in some confectionery products in food processing (Bawa, et al., 2007). As a seasonal crop, price tends to skyrocket during off-season, so, attempts made to store and minimize spoilage of onion is still not very efficiently practiced among farmers in Africa. The high moisture content is thought to play a role in microbial infestations of onions during storage (Akbari, 2001).

This study aimed to determine the effect of light transparency packaging material on total phenolic contents, proximate composition and microbial count of onion powder during and after storage

MATERIALS AND METHODS

Sample Collection and Preparation

Red onion (*Allium cepa*) variety commonly known as *yan gashua* in Hausa language was purchased directly from onion farmers at Kura local government, Kano in January, 2020. After sorting, the onion bulbs were blanched in hot water containing 2.5% normal saline solution for 5-10 minutes and then sliced to about 2mm thickness using vegetable slicer and then drained. The sliced onion bulbs were thereafter dried using food dehydrator (BOSCH BS-6612) set at 60°C for 24 hours (Anju, 2010). The dried slices were finely blended into powder form and exactly 300 g was weighed and packaged in each of 12 glass jars of which six were ambered coloured while the other six were transparent. Analyses of sample were carried out on monthly basis for total polyphenolic contents and every three months for proximate composition and microbial count.

Proximate Analyses of Onion Powder

The proximate analyses of the crude fibre, fat, crude protein, carbohydrate, as well as moisture and ash contents were analysed in line with

standard protocols of analyses (AOAC, 2007) for the first, third and sixth month of storage.

Sample Extraction and Determination of Total Polyphenol

Exactly 500 mg of onion powder was added to 25 ml of 80% methanol then sonicated for 1 hour. The mixture was then centrifuged at 3000 RPM for 30 minutes and extract was collected twice after being spun for the second time into Eppendorf tubes wrapped with aluminium foil left at room temperature while analyses followed up immediately. Total polyphenols contents (TPC) of onion powder were determined prior to storage and for the stored samples of the onion powder in amber and transparent storage jars according to the methods described by Lachman et al. (2003) and were expressed in milligrams gallic acid equivalent (mg/g GAE) of dried weight matter.

A stock solution of 250 mg/L gallic acid was prepared then serially diluted to obtain concentrations of 50, 100, 150 and 200 mg/L following methods of Atawodi et al. (2011). Absorbance was taken at 765 nm for each of 0.25 mL of the standard solutions to obtain a calibration curve. Similarly, 0.25 ml of 500 mg/L of each sample was added to 2.5 ml FolinCiocalteu Reagent (FCR) followed by 2.0 mL of 1M sodium carbonate. The reaction mixtures were allowed to stand at room temperature for 15 minutes in a dim lighted room. Absorbance was then measured spectrophotometrically at 765nm using a T80 PG-UV/Vis spectrometer while 0.25 mL of methanol-water (50:50) was used as blank. TPC was expressed as gallic acid equivalent (GAE) mg/g dry weight (DW) of sample estimated using the equation: $y = 0.0053x + 0.0023$ obtained from the calibration curve of gallic acid standard.

Microbial Analysis

Microbial counts were carried out on the dried onion sample from different storage jars as described by APHA, (2001). Exactly 1.0 g of onion powder was prepared in 9 mL of peptone water and 1 mL of the stock solution was serially diluted up to 10^{-4} in 9 mL of peptone water.

About 0.1 mL aliquots were spread on plated nutrient agar (NA), MacConkey agar (MCA) and potato dextrose agar (PDA) for the enumeration of aerobic viable bacteria, coliforms and fungi respectively. The inoculated NA and MCA plates were incubated at 37°C for 48 hours while the PDA plates were incubated at room temperature for 7 days. Fungal growth was observed by physical observation and lactophenol cotton blue staining technique as described by Alexopoulos and Mims (1979).

The colonies were then counted and expressed as colony forming units per gram (cfu/g) of samples. Observed colonies were subcultured repeatedly on media used for primary isolation to establish pure cultures. All counts were done in duplicate using Stuart scientific colony counter. Isolates of bacteria were identified based on colony morphology, Gram stain reactions and biochemical characteristics was in accordance with established standard protocols for known taxa as in Bergey's Manual of Systematic Bacteriology (Holt *et al.*, 1994).

Data Analysis

Experimental analyses were carried out in triplicate and data were expressed as means ± standard deviation. Data were analyzed using the t-test (SPSS 16.0 version 2007) to determine the statistical significance ($p < 0.05$).

RESULTS AND DISCUSSION

Total Polyphenol Contents (TPC)

The results of total polyphenol contents of onion powder stored in amber and transparent jars are

presented in Table 1. Before storage, the TPC was evaluated to be 14.60 ± 1.08 GAE (mg/g) dry weight of onion powder sample used. The TPC values decreased with time of storage in both type of storage materials but a significant ($p < 0.05$) difference in the level of total polyphenol contents of the stored onion powder in the amber and transparent jars was however observed. That is, 5.92 ± 0.76 GAE mg/g for TPC in amber jar as compared with 1.64 ± 0.78 GAE mg/g in transparent jar. This implies a reduction of 59.5% and 88.8% in TPC as recorded in amber and transparent storage jars, respectively at the end of six month storage.

Total polyphenol contents of foods tend to decline due to processing and storage (Judita *et al.*, 2014; Cieslik *et al.*, 2006). The rate of decline in the content of total polyphenols in this study was greater after the third month of storage in the transparent jars. This may be probably due to the prevailing weather conditions which made the room temperature higher around April in the northern part of Nigeria.

Total polyphenols content of onion powder is sensitive to light, heat, variety of onion and the method of dehydration (Anju *et al.*, 2010; Chang *et al.* 2013). When onion is subjected to dehydration or stored in material that allows the passage of light, deterioration of bioactive components such as phenolics and flavonoids are imminent due to cleavages of esterified and glycosylated bonds (Maillard, 1988).

Table 1: Level of total polyphenol contents of onion powder during storage

STORAGE TIME (MONTHS)	AMBERED JARS GAE (mg/g)	TRANSPARENT JARS GAE (mg/g)
0	14.60 ± 1.08^a	14.60 ± 1.08^a
1	13.72 ± 0.21^d	12.72 ± 0.38^e
2	11.34 ± 1.32^f	9.96 ± 0.96^h
3	9.20 ± 0.34^e	8.69 ± 0.22^c
4	8.06 ± 0.94^c	4.54 ± 0.94^b
5	7.56 ± 1.16^b	2.40 ± 0.94^d
6	5.92 ± 0.76^h	1.64 ± 0.78^f

Values are data expressed as mean ± SD of three replicates. Different superscript in the same row indicates significant difference at $p < 0.05$. DW = dried weight of sample.

Proximate Composition and Energy Content

Results of proximate composition of onion powder stored in amber and transparent jars are presented in Table 2. There were significant ($p < 0.05$) differences in the proximate composition of onion powder stored in amber and transparent jars. Moisture content ranged from initial $2.19 \pm 0.01\%$ before storage to $8.12 \pm 0.83\%$ and $7.22 \pm 0.12\%$ in amber and transparent jars, respectively at the end of storage. The onion powder contained in amber jars had more moisture (about 0.9%) higher than those in transparent jars. This could probably be associated with the principle of heat transfer that dull or black objects absorb more heat, while transparent objects reflect more heat. Moisture content therefore, is an important parameter in flour (powder) which significantly affect shelf life of food products. Flour or powder products with moisture content less than 13% are less affected from moisture dependent deterioration (Shahzadi *et al.*, 2005).

After the sixth month of storage, crude fiber contents of onion powder in amber and transparent storage jars increased by 0.33% and 0.26%, respectively against the initial value of $5.93 \pm 0.01\%$ before storage. Consumption of fiber containing food products has been linked to reduction in hemorrhoids and obesity (Chukwu *et al.*, 2013). The protein content as evaluated increased from initial $7.51 \pm 0.07\%$ before storage to $9.58 \pm 0.08\%$ and $9.19 \pm 0.06\%$ in amber and transparent jars, respectively. The more protein recorded with the amber jar content probably correlate with the more moisture content evaluated in the amber jars. The level of water sorption had been reported to influence the stability of protein in solid state (Micheal, 1988). Ash content was evaluated to have a downward trend after the third and sixth month of onion storage in both jars. The ash content of onion powder in the transparent jars decrease more to about 7% lesser than for those onion powder in amber jars at the end of storage. Fat content ranged from $0.63 \pm 0.01\%$ before storage to $0.48 \pm 0.01\%$ and $0.45 \pm 0.02\%$ in amber and transparent jars after the sixth month of storage.

Food containing less amount of fat stays longer in storage because, high amount of fat could lead to unpleasant smell caused by rancidity during storage (Gupta and Shukla, 2017).

Carbohydrate contents decreased in both storage jars at the end of the sixth month of storage. There were 6.59% and 8.05% reduction in carbohydrate contents of onion powder in transparent and amber jars from the initial 82.85% before storage. The decrease of carbohydrates could be due to breakdown of carbohydrates sub-units in a reaction which is temperature dependent and extensively on intermediate water activities. This was more observed with amber jars where moisture contents were higher as a result of more heat absorption from the environment. The energy value was estimated to have dropped by 6.88% and 5.79% from onion powder stored in amber and transparent jars, respectively from the initial value of 367.11 Kcal/g before storage. The more energy value in the onion powder stored in transparent jars is associated with the more carbohydrate content.

Microbial Assays

The total plate count (cfu/g) for microbial load analysis is presented in Table 3. It was observed that no growth (NG) was noticed in the zeroth month until the third and sixth months of storage. At the third months of storage, there were more fungal counts (7.0×10^2 cfu/g) in the transparent glass jar than recorded for the stored onion powder in the amber colored glass jars (2.0×10^2 cfu/g). Likewise, more bacteria were recorded in the stored onion powder in transparent jars (3.0×10^2 cfu/g) than in the amber colored glass jars (1.8×10^1) at the end of the third months. At the end of the study period (sixth month) of storage, similar trend continued of more microbial counts in transparent glass jars (3.5×10^3 cfu/g and 6.1×10^5 cfu/g bacterial and fungal, respectively) than was recorded for stored onion powder in amber glass jars (2.1×10^2 and 3.0×10^3 bacterial and fungal, respectively). Beside blanching and salting which were pretreatment during preparatory

stage, minimal microbial growth in the stored onion powder evaluated in the third and sixth months of storage could also be due to onion inherent antimicrobial properties attributed to the quercetin and some ample amount of allicin contents (Gupta and Shukla, 2017; Ankri and

Mirelman, 1999). Isolated species from sample after blanching and salting could probably be of heat and salt resistant (Kadam *et al.*, (2009).

Table 2: Proximate composition of dried onion powder stored in amber and transparent glass jars

PROXIMATE PARAMETERS (%)	STORAGE TIME (MONTH)	AMBERED JARS	TRANSPARENT JARS
MOISTURE CONTENT	0 th	2.19 ^a	2.19 ^a
	3 rd	3.88 ^b	3.75 ^c
	6 th	8.12 ^c	7.22 ^d
CRUDE FIBRE	0 th	5.93 ^b	5.93 ^b
	3 rd	5.99 ^a	5.95 ^c
	6 th	6.26 ^e	6.19 ^b
CRUDE PROTEIN	0 th	7.51 ^c	7.51 ^c
	3 rd	8.89 ^a	8.85 ^d
	6 th	9.58 ^c	9.19 ^a
ASH CONTENT	0 th	0.89 ^d	0.89 ^d
	3 rd	0.85 ^a	0.81 ^c
	6 th	0.76 ^b	0.69 ^a
FAT CONTENT	0 th	0.63 ^e	0.63 ^e
	3 rd	0.60 ^a	0.59 ^b
	6 th	0.48 ^c	0.45 ^d
CARBOHYDRATE CONTENT	0 th	82.85 ^f	82.85 ^f
	3 rd	79.79 ^a	80.83 ^b
	6 th	74.80 ^a	76.26 ^c
ENERGY VALUE (KCal/g)	0 th	367.11 ^g	367.11 ^g
	3 rd	360.12 ^a	364.03 ⁿ
	6 th	341.84 ^c	345.85 ^e

The values are means of three replicates. Different superscript in the same row indicates significant difference at $p < 0.05$.

Table 3: Total plate count of dried onion samples during storage

STORAGE TIME (MONTH)	AMBERED JARS	TRANSPARENT JARS	MICROBES TYPE
0	NG	NG	
3	1.8×10^1	3.0×10^2	Bacteria
6	2.1×10^2	3.5×10^3	Bacteria
0	NG	NG	
3	2.0×10^2	7×10^2	Fungi
6	3.0×10^3	6.1×10^5	Fungi

NG = No growth. Bacterial isolates were *Staphylococcus sp.* and *Bacillus Sp.* Fungal isolates were yeast and *Aspergillus sp.*

Table 4: Microscopic description of isolated organisms

PHYSICAL OBSERVATION	MICROSCOPIC OBSERVATION	ORGANISM
Black colonies with dotted grey on its apex	Filamentous, thick septate hyphae, conidia appeared in chains from the sterigmata	Aspergillus species
Creamy colonies	Oval shaped with short multilateral budding	Yeast
Golden yellow and pale-pink colonies	Circular and grape-like cluster	Presumed Staphylococcus species.
Fuzzy white, slight yellow colonies.	Appeared in pair, rounded square end (rod-like). Single endospore	Presumed Bacillus species

Tables 4 and 5 showed the morphological description of the isolated microbes and the biochemical tests of isolated bacteria. Two fungi species (aspergillus and yeast) were identified with the stored onion powder from the third month of storage in both storage materials. Similarly, Bacillus and Staphylococcus species were identified after morphological and biochemical

characteristics and also identified after the third month of storage in both jars. Based on guidelines contained in the ICMSF revised edition (2014), the level of colony counts for all the species of organisms isolated from the stored onion powder are still in the safe level since the counts had up to an infective dose of $\geq 10^7$ cfu/g.

Table 5: Biochemical test of isolated bacteria

BACTERIA	GRAM REACTION	CAT	IND	MR	MOT	CIT	COA
STAPHYLOCOCCUS SPECIES	+ Cocci	+	-	-	-	-	+
BACILLUS SPECIES	+Rod	+	-	-	-	-	+

+ = positive to test; - = negative to test; CAT= catalase; IND= indole; MR= methyl red; MOT= Motility; CIT= citrate; COA= coagulase.

CONCLUSION

The stored onion powder produced from red variety of northern Nigeria was evaluated for total polyphenols contents, proximate analyses and microbial loads before, during and after storage in amber and transparent jars. Results obtained from this study proved that amber storage jars are better than transparent storage jars. This perception is due to the more retention in the contents of total polyphenolic and proximate parameters recorded during the storage period of six months. Microbial counts in both jars were within safe levels nevertheless, fewer counts were recorded in the stored onion powder of amber storage jars. For enhanced utilization of onion in terms of value addition and to minimize

postharvest wastage of fresh onion bulbs, findings from this current study suggest that when onion powder is produced and considered for storage for home or industrial use, amber coloured storage materials should be preferred to transparent material for better nutritional quality retentions.

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Bala et al: Nutritional Quality Evaluation of Stored Onion (*Allium cepa* L.) Powder...

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