Original Research Article

Effect of Some Packaging Materials on Shelf Life and Quality Attributes of Ground Pepper During Storage

ABSTRACT

The effects of selected packaging materials on the storage, carotenoid content and sensory properties of ground pepper was investigated. Ground pepper was packed with polypropylene of different thickness such as (PP) 3 micron, 4 micron, 5 micron, 12.5 micron, 20 micron and 30 micron. Samples were analyzed for changes in proximate, carotenoid, mould count and sensory qualities at days 0, 30 and 60 for two months during storage at room temperature. The moisture (7.94 - 8.28%) and carbohydrate (33.21 - 35.77%) contents increased while protein (10.20 - 9.43%), fat (16.97 - 16.17%), ash (5.58 - 5.01%) and crude fibre (26.11 - 25.29%) contents decreased with the prolongation of storage period but significant ($p>0.05$) difference were not recorded between the various packaging materials. There was a significant ($p<0.05$) decrease in the carotenoid content of different packaging materials with a better level retained in PP 30 micron (19.27mg/g) and PP 20 micron (16.12mg/g) after 60 days of storage. There was also an increase in the mould count of the ground pepper packed with different packaging materials with PP 20 micron (2.8×10^4cfu/g) and PP 30 micron (4.1×10^4cfu/g) having the least counts. Sensory evaluation result showed that samples packed in PP 30 micron had better retention of pungency, PP 20 micron for aroma and PP 12.5 micron for colour. However, there was no significant ($p>0.05$) difference in the overall acceptability of the ground pepper as influenced by packaging materials. The PP 30 micron and 20 micron proved very useful for the storage of ground pepper for longer shelf life and good retention of carotenoid content, colour and pungency up to two months of storage period.

Keywords: *Pepper Fruit, Packaging Materials, Shelf Life, Phytochemicals, Quality Attributes' Retention, Microbial Count,*

1. INTRODUCTION

Pepper fruits (*Capsicum annum*) are important vegetable widely used as spice condiments and there are varieties of these condiments. They second most popular vegetable after tomatoes used in cooking [1]. Nigeria has an abundance of pepper varieties being the highest producer in Africa [2]. They are grown for their sensorial characteristics of colour, aroma and pungency. They are good source of nutritional phytochemicals such as carotenoids, tocopherols, ascorbic acid and phenolic compounds [3]. They are also rich in capsaicinoids which is responsible for the taste, pungency and its hotness [4].

Ground *Capsicum* also known as paprika has a high demand in the domestic and international markets. They can be used as natural food colourants or seasoning agents due to their colour, flavour and pungency depending on the specie. They can also be used to modify the flavour of foods such as soups, stews and sausages as well as standard ingredient and as a flavour additive in processed foods [5]. The main parameters of ground pepper are colour and pungency [6]. Handlers and

consumers of ground pepper therefore attach a lot of importance to the retention in the colour and pungency. This is why packaging of this pepper product is important as temperature, air, sunlight and relative humidity can cause losses in the quality attributes.

Packaging materials play a significant role for better shelf life of the packed product. Packaging supplies an adequate environmental condition for shelf life extension of foods. Ground and powdered pepper requires protection against moisture, oxygen and loss of flavour and colour compounds. Carotenoids present in ground pepper are susceptible to degradation, oxidation and isomerization due to the effect of light and heat thereby resulting to colour loss [7]. Packaging them with suitable packaging materials will provide a good market value and also ensure quality for consumer's requirement. In recent days, different packages have been used to package food products so as to increase its shelf life. However, the storage life of the product depends on the appropriate selection of the packaging films. The effectiveness of different packaging materials used will not be the same as each material will have different permeability rates. Permeability of the packaging films to water vapour and gases is considered for shelf life [8].

Considering the demand of ground pepper, efforts has been made to study the most appropriate packaging material to increase its shelf life. Polypropylene, plastics, polyethylene among others are widely used in the market to package ground pepper. On this premise, the present study was designed to further evaluate the effect of packaging materials on the proximate, carotenoid and sensory properties, as well as the rate of microbial growth during 60 days of the storage period.

2. MATERIALS AND METHODS

2.1 Materials

Dried chili pepper was procured from Mile 3 market Port Harcourt, Rivers State, Nigeria. Packaging materials used were polypropylene packages of different thickness such as 3 micron, 4 micron, 5 micron, 12.5 micron, 20 micron and 30 micron as labeled by the manufacturers. These packaging materials were purchased from Trans-Amadi in Port Harcourt. All chemicals used were of the analytical grades, products of BDH chemical Ltd pool, England and were obtained from Food Technology Laboratory, Department of Food Science and Technology, Rivers State University, Port Harcourt, Nigeria.

2.2 Methods

2.2.1 Sample Preparation, Packaging and Storage Condition

Two kilograms of chilli pepper berries were cleaned, sorted and oven dried at 50^{o}C for 24h in a hot air fan oven (Model QUB, 305015, Gallenkamp, UK) and ground using a laboratory mill (Numex and Pep Grinding Mill, India). Fifty grams of the milled pepper samples were packed in polypropylene of thickness 3µ, 4µ, 5µ, 12.5µ, 20µ and 30µ. All samples were stored at room temperature (28±2^{o}C) for a period of two months. Pepper samples were analyzed at the intervals of 0, 30 and 60 days of storage for proximate, carotenoid, sensory properties and for the isolation of moulds using a complete randomised design.

2.2.2 Proximate Analysis of the Ground Pepper Samples

Moisture, ash, crude protein, crude fat and crude fibre contents were determined according to AOAC [9] standard method while carbohydrate content was determined by difference.

2.2.3 Total Carotenoid Determination

Total carotenoid of the pepper samples were estimated using the methods of Harbone [10]. The sample (0.5g) was weighed into a centrifuge tube and 10ml of 80% acetone added. It was mixed properly and centrifuged at 4000rpm for 10mins and filtered. The supernatant was made up to a volume of 15ml using 80% ethanol. The optical density (absorbance) was read at a wavelength of 480nm using ultraviolent (UV) visible spectrophotometer and was calculated as thus;

$$Total\ Carotenoid\ Content\ \left(\frac{mg}{kg}\right) = \frac{4 \times OD \times Total\ Vol.\ of\ Sample \times 1000}{Sample\ Weight}$$

2.2.4 Isolation of Moulds

Twenty five grams of the sample was weighed and dissolved into 225ml of prepared diluents and mixed to dissolve completely (10^{-1}). One milliliter was measured from the first dilution (10^{-1}) into the second and the third diluents (10^{-2}). From the last dilution, 0.1ml was measured and inoculated in a prepared plate of Sabouraud Dextrose agar (SDA) and incubated at 28±2^{o}C for 2 days before colonies were counted [11] using colony counter(model SC6,Bibby Sterilin Ltd ,U.K).

2.2.5 Sensory Evaluation

The sensory attributes of the ground pepper samples were obtained by using simple hedonic tests as described by Larmond [12]. This was done using a 20 member panel comprising of students of the Department of Food Science and Technology, Rivers State University who are familiar with the sensory attributes of pepper. The Judges were asked to score each attribute on a 9-point hedonic scale where 1 and 9 represent dislike extremely and like extremely, respectively. The attributes that were evaluated include colour, pungency, aroma, flavour and overall acceptability.

2.2.6 Statistical Analysis

The data obtained were subjected to Analysis of Variance (ANOVA) using Statistical Package for Social Sciences (SPSS) version 20.0, software 2011. All analysis were done in duplicate and means separated using the Least Significant Difference test (LSD).

3. RESULTS AND DICUSSION

3.1 Proximate Composition of Ground Pepper

Effect of packaging materials on the proximate compositions of ground pepper are presented in Figures 1 to 6. The result showed that the moisture content of the pepper increased from 7.94% (at day 0) to 8.28% (at day 60). It was observed that the packaging materials significantly ($p>0.05$) did not affect the moisture content of the pepper samples rather, they were affected by the storage period. The change in moisture content during storage may be attributed to the permeability of these packaging materials to water and gas. It may also be due to the condensation of respiratory water on the inside of the packaging materials. Kumar and Mishra [13] also reported a gradual increase in the moisture content of mango yoghurt powder during storage when packed with polypropylene packages. Panda *et al.* [14] equally reported an increase in strawberry packed with materials. Moisture content is an indicator of shelf stability and an increase in moisture content can enhance microbial growth leading to food deterioration [15]. The recommended safe level of moisture content during storage of food powders is within the range of 12 - 14% [16]. Moisture content of all the non-stored and stored pepper samples fall within this range. Moisture content of the ground pepper samples were equally within the range reported by Esayas *et al*. [17] for some capsicum varieties.

Protein, fat and crude fibre contents of the ground pepper samples decreased with storage period. Protein decreased from 10.20 - 9.43%, fat 16.97 - 16.17% and crude fibre 26.11 - 25.29%. There was an increase in the carbohydrate content from 33.21 - 35.77%. These reductions in protein, fat and fibre have also been reported by Adebowale *et al*. [18] for water yam flour under different packaging materials. This may be attributed to the growth of microorganisms as a result of the increase in moisture content. Achi and Akubor [19] stated that increased moisture can lead to the disintegration of nutrients of food. Samples stored in polypropylene of thickness 30 micron and 20 micron recorded the least protein, fat, fibre and carbohydrate depletion. There was no significant ($p>0.05$) difference in the protein, fat and crude fibre content of ground pepper samples packed in different packaging materials implying that packaging had no significant effect during the storage period of 60 days. This trend was also reported by Pavani and Aduri [20] who observed no significant difference between packaging materials at 5% level of significance after 45 days of storage in both dried spinach and amaranths leaf powder.

The ash content is an indication of the mineral element of food and was observed to decreased during storage period from 5.58 - 5.01%. There was also no significant ($p>0.05$) difference in the ash content of the pepper samples as affected by packaging. These values are within the range reported by Emmanuel-Ikeme *et al*. [21]. This decrease could be as a result of biochemical activities of microorganisms. Pepper samples stored in polypropylene of thickness 30 micron and 20 micron were also seen to record the least depletion.

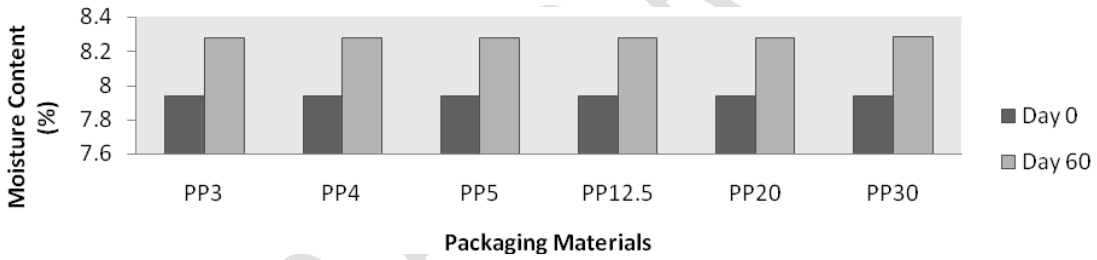


Figure 1: Effect of Packaging Materials on Moisture Content of Ground Pepper

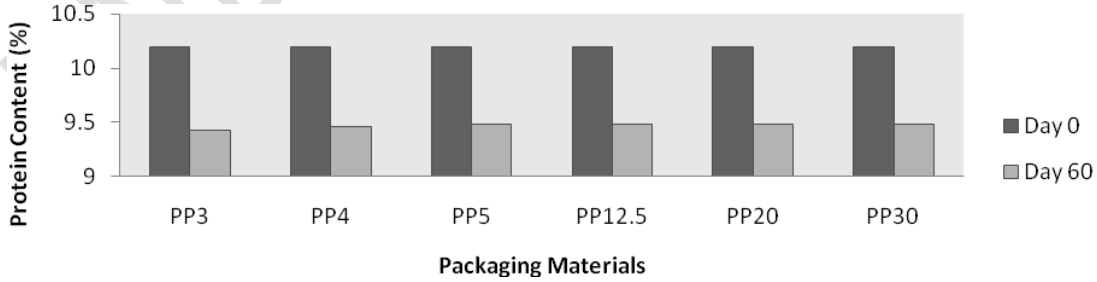
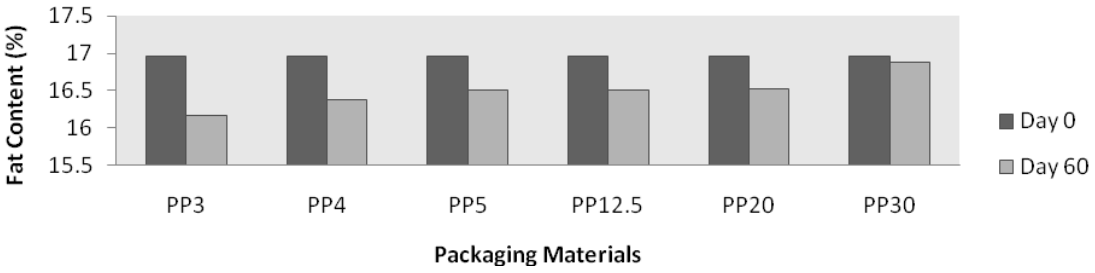


Figure 2: Effect of Packaging Materials on Protein Content of Ground Pepper



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157 **Figure 3:** Effect of Packaging Materials on Fat Content of Ground Pepper

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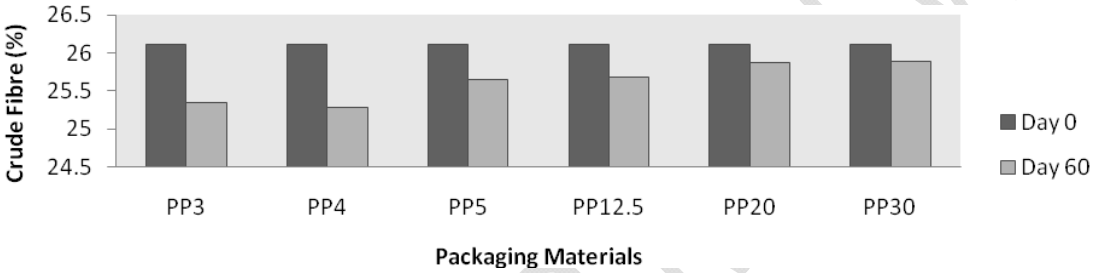

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161 **Figure 4:** Effect of Packaging Materials on Crude Fibre Content of Ground Pepper

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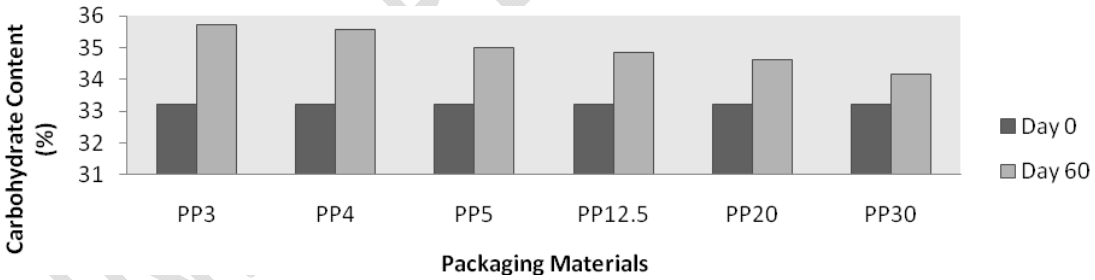

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165 **Figure 5:** Effect of Packaging Materials on Carbohydrate Content of Ground Pepper

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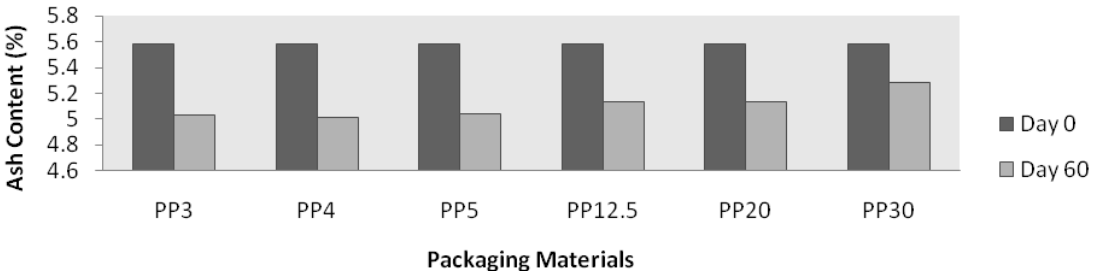

Figure 6: Effect of Packaging Materials on Ash Content of Ground Pepper

Keys:
PP3µ = Polypropylene 3 micron
PP4µ = Polypropylene 4 micron
PP5µ = Polypropylene 5 micron
PP12.5µ = Polypropylene 12.5 micron
PP20µ = Polypropylene 20 micron
PP30µ = Polypropylene 30 micron

3.2 Carotenoid Content of Ground Pepper

Effect of packaging materials on the carotenoid content of ground pepper is shown in Table 1. It was observed that carotenoid content of the ground pepper packed in different packaging materials varied significantly ($p<0.05$) over the storage period. There was a decrease in the carotenoid content on day 30 with maximum carotenoid recorded in ground pepper packed with PP 30 microns (24.36mg/g) followed by PP 20 micron (22.02mg/g) and PP 12.5 micron (21.42mg/g) while PP 3 micron, PP 4 micron and PP 5 micron recorded 2.31mg/g, 17.43mg/g and 19.35mg/g, respectively. At day 60, there was a decrease in the carotenoid content of the samples with maximum value recorded in the sample packed with PP 30 micron (19.27mg/g). Over the prolongation of the storage period, the total carotenoid content was on a decreasing trend. This decrease might be attributed to the modification of the atmosphere inside the packaging materials with respect to oxygen concentration [22]. Different packaging materials have varying water vapour, oxygen transmission rate and sunlight resistance as reported by Allahvaisi [23] which might have affected the carotenoid contents. This might also be due to the oxidation and degradation of carotenoid pigment as light catalyzes the oxidation reaction [24]. This decreasing trend in carotenoid content was equally observed by Awoyale *et al.* [25].

Table 1. Effect of Packaging Materials on the Carotenoid Content of ground pepper powder

	Storage Period (Days)		
Storage Materials	**0**	**30**	**60**
A	27.79±0.00^{a}	21.31±0.00^{c}	14.34±0.00^{c}
B	27.79±0.00^{a}	17.43±0.33^{e}	11.84±0.34^{e}
C	27.79±0.00^{a}	19.35±0.33^{d}	13.75±0.17^{d}
D	27.79±0.00^{a}	21.42±0.00^{c}	14.71±0.33^{c}
E	27.79±0.00^{a}	22.02±0.16^{b}	16.12±0.16^{b}
F	27.79±0.00^{a}	24.36±0.17^{a}	19.27±0.00^{a}
LSD	**0.00**	**0.51**	**0.59**

Values bearing different superscript within the same column differ significantly ($p<0.05$) at 5% level of probability, ± standard deviation of duplicate determination.

Keys:
A = (PP3µ) Polypropylene 3 micron
B = (PP4µ) Polypropylene 4 micron

C = (PP5µ) Polypropylene 5 micron
D = (PP12.5µ) Polypropylene 12.5 micron
E = (PP20µ) Polypropylene 20 micron
F = (PP30µ) Polypropylene 30 micron

3.3 Mould Count of Ground Pepper

Effect of packaging materials on the mould count of stored ground pepper powder is presented in Table 2. An increase in the mould count was observed in the samples during storage period. At day zero, mould count for all the pepper samples were 3.0×10^3Cfu/g. They increased to the range of 3.9×10^4Cfu/g to 4.3×10^5Cfu/g at day 30 with PP 12.5 micron, PP 20 micron and PP 30 micron recording lower mould counts. At day 60, mould count ranged from 2.8×10^4Cfu/g to 8.0×10^5Cfu/g with PP 20 micron, PP 30 micron and PP 12.5 micron recording lower counts. An increase in the mould count could be due to increasing moisture content during storage. The difference in the level of mould load in all the ground pepper packed with different packaging materials could probably be due to the relative permeability of these materials to atmospheric gases such as oxygen, carbon dioxide and water vapour [26]. This increase was also reported by Adebowale *et al.* [18] in water yam flour stored with different packaging materials. Polypropylenes of thickness 12.5µ, 30µ and 20µ exhibited a better protection against mould attack thereby acting as an effective barrier and better packaging material for food shelf life.

Table 2. Effect of Packaging Materials on the mould count (Cfu/g) of ground pepper

	Storage Period (Days)		
Storage Materials	**0**	**30**	**60**
A	$3.0x10^3$	$4.1x10^5$	$5.0x10^5$
B	$3.0x10^3$	$4.3x10^5$	$8.0x10^5$
C	3.0×10^3	$4.1x10^5$	$7.0x10^5$
D	$3.0x10^3$	$3.8x10^5$	$4.9x10^4$
E	$3.0x10^3$	$3.8x10^5$	$2.8x10^4$
F	$3.0x10^3$	$3.9x10^4$	$4.1x10^4$

Mean values are outcome of duplicate determination.

Keys:
A = (PP3µ) Polypropylene 3 micron
B = (PP4µ) Polypropylene 4 micron
C = (PP5µ) Polypropylene 5 micron
D = (PP12.5µ) Polypropylene 12.5 micron
E = (PP20µ) Polypropylene 20 micron
F = (PP30µ) Polypropylene 30 micron

3.4 Effect of Packaging Materials on the Sensory Attributes of Ground Pepper

The sensory attributes of colour, flavour and aroma on day 0 were 6.7, 7.30 and 7.35, respectively while pungency and overall acceptability of the ground pepper were 7.95 and 8.35, respectively as presented in Table 3. At 60 days of storage period, the colour of the pepper samples ranged from 6.55 - 7.40, flavour 6.0 - 7.65, aroma 6.80 - 7.60, pungency 7.2 - 8.05 and overall acceptability 7.25 - 7.80. There was no significant ($p>0.05$) difference in the overall acceptability of the stored pepper samples. PP 12.5µ was most preferred for colour, PP 20µ for aroma and overall acceptability while PP 30µ was most preferred for flavour and pungency. The changes observed in the sensory scores of the ground pepper in the different packaging materials may be associated with the level of protection offered by the packaging materials such as permeability, absorption or migration properties of the polypropylenes and microbial action [27]. The findings are in close aggregation with that of Panda *et al.* [14]. The color of the pepper packaged with polypropylene of high thickness were most preferred than those of low thickness. This might be attributed to the characteristic feature of these films having a proper balance for the permeability of CO_2 O_2 and relative humidity.

Table 3. Effect of Packaging Materials on the sensory scores of ground pepper

	Colour		Aroma		Flavour		Pungency		Overall Acceptability	
	Storage Period (Days)									
Storage Materials	**0**	**60**	**0**	**60**	**0**	**60**	**0**	**60**	**0**	**60**
A	6.75^{a}	6.55^{b}	7.35^{a}	6.80^{d}	7.30^{a}	6.90^{b}	7.95^{a}	7.25^{b}	8.35^{a}	7.25^{a}
B	6.75^{a}	7.25^{ab}	7.35^{a}	7.00^{cd}	7.30^{a}	7.30^{a}	7.95^{a}	7.60^{ab}	8.35^{a}	7.30^{a}
C	6.75^{a}	6.90^{a}	7.35^{a}	7.20^{bcd}	7.30^{a}	7.45^{ab}	7.95^{a}	7.65^{ab}	8.35^{a}	7.45^{a}
D	6.75^{a}	7.40^{a}	7.35^{a}	7.30^{abc}	7.30^{a}	7.40^{ab}	7.95^{a}	7.65^{ab}	8.35^{a}	7.40^{a}
E	6.75^{a}	7.15^{ab}	7.35^{a}	7.60^{a}	7.30^{a}	7.15^{ab}	7.95^{a}	7.85^{ab}	8.35^{a}	7.15^{a}
F	6.75^{a}	7.30^{a}	7.35^{a}	7.50^{ab}	7.30^{a}	7.65^{a}	7.95^{a}	8.05^{a}	8.35^{a}	7.65^{a}
LSD	**0.00**	**0.60**	**0.00**	**0.46**	**0.00**	**0.65**	**0.00**	**0.77**	**0.00**	**0.77**

Values bearing different superscript within the same column differ significantly ($p<0.05$) at 5% level of probability, ± standard deviation of duplicate determination.

Keys:

A = (PP3µ) Polypropylene 3 micron
B = (PP4µ) Polypropylene 4 micron
C = (PP5µ) Polypropylene 5 micron
D = (PP12.5µ) Polypropylene 12.5 micron
E = (PP20µ) Polypropylene 20 micron
F = (PP30µ) Polypropylene 30 micron

4. CONCLUSION

The present study establish that pepper can be stored for a longer period and different packaging materials can help facilitate its storage and shelf life at room temperature for up to two months. Polypropylene of thickness 30 micron and 20 micron attest to be the most effective measure in controlling the decrease observed in the proximate and carotenoid contents of the stored pepper samples, as well as efficient in reducing the microbial load of the stored ground pepper samples.

Ethical approval and consent are not applicable.

REFERENCES

1. Yamaguchi, M. (1983). World vegetables, principles and nutritive values. The Ari Publishers.com-inc., West Port Connecticut pp: 303-306.
2. Raji, A.G.O., Falade, K.O. and Abimbolu, F.W. (2010). Effect of sucrose and binary solution on osmotic dehydration of bell pepper (chilli) (capsicum spp) varieties. *Journal of Food Science and Technology*, 47(3):305-309. doi: 10.1007/s13197-010-0048-7.
3. Nagy, X., Daood, H., Ambrozy, Z., and Helyes, L. (2015). Determination of Polypropylene, capsaicinoids and vitamin C in new hybrids of chili peppers. *Journal of Analytical Methods in Chemistry.* Article 1-10: 102.25 dio:101155/2015/102125.
4. Liu, Y. and Nair, M.G. (2010). Non-pungent functional food components in the water extracts of hot peppers. *Food Chemistry,* 122, 731-736.
5. Swain, S., Samuel, D.V.K. and Kar, A. (2013). Effect of packaging materials on quality characteristics of osmotically pretreated microwave assisted dried sweet pepper (Capsicum annum L.) *Journal of Food Processing*.
6. Carvagal, M., Martinez, M.R., Martinez-Sanchez, F. and Alcaraz, C.F. (1997 check the name and the year). Effect of ascorbic acid addition to peppers on paprika quality. *Journal of the Science of Food and Agriculture,* 75(4), 442-446. Doi:10.1002/(SICI)1097-0010(199712)75:4<442::AID-JSFA899>3.0.CO;2-1

7. Deli, J., Molner, Matus, Z. and Toth, G. (2001). Cantenoid composition in the fruits of red paprika (Capsicum Annuum Var, Lycorersicitorme Rubrum) during ripening, biosynthesis of carotenoids in red paprika. *Journal of Agriculture and Food Chemistry*, 49:1517 – 1523.
8. Siracusa, V. (2012). Food packaging permeability behaviour: a report. *International Journal of Polymer Science,* 1-11. Doi: 10.1155/2012/302029.
9. AOAC (2012) Association of Official Analytical Chemists. Official Methods of Analysis, 19th Edition Washington, DC USA.
10. Harbone, J.B. (1973). Phytochemical methods. Chapman and Hall, London.
11. Jideani, V.A. and Jideani, I.A. (2006). Laboratory Manual of Food Bacteriology Amana Printing and Advertising Limited Kaduna – Nigeria.
12. Larmond, E. (1991). Laboratory Methods for Sensory Evaluation of Foods. Canadian Agricultural publications. Series IV, Ottawa. Canada.
13. Kumar, P. and Mishra, H.N. (2004). Storage stability of mangosoy fortified yoghurt powder in two different packaging materials: HDPP and AIP, *Journal of Food Engineering* 65(4):569-576.
14. Panda, A.K., Goyal, R.K., Godara, A.K. and Sharma, V.K. (2016). Effect of packaging materials on the shelf life of strawberry CV-Sweet Charlie under room temperature Storage. *Journal of Applied and Natural Science*, 8(3), 1290-1294.
15. Adejumo, B.A. (2013). Some quality attributes of locally produced wheat flour in storage *IOSR Journal of Environmental Science, Toxicology and Food Technology,* 5(2):47-49.
16. Standard Organization of Nigeria (2004). Standard for edible cassava four (Standard No. 344). Lagos Nigeria Industrial.
17. Esayas, K., A. Shimelis, F. Ashebir, B. Tilahun & D. Gulelat, (2011). Proximate composition, Mineral content, and Anti-nutritional factors of some capsicum (Capsicum annum) varieties grown in Ethiopia. *Journal of the Korean society of Food Science and Nutrition*, 37(8), 1084-1089.
18. Adebowale, A.A., Owo, H.O., Sobukola, O.P., Obadina, O.A., Kajihausa, O.E., Adegunwa, M.O., Sanni, L.O and Tomlins, K (2017). Influence of storage conditions and packaging materials on some quality attributes of water yam flour. *Cogent Food and Agriculture*, 3, 1-26.
19. Achi, O.K and Akubor, P.I. (2000). Microbiological characterization of yam fermentation for 'Elubo (yam flour) production. *World Journal of Microbiology and Biotechnology*, 16(1), 3-7.
20. Pavani, K.V. and Aduri, P. (2018). Effect of packaging materials on retention of quality characteristics of dehydrated green leafy vegetable during storage. *International Journal Environments, Agriculture and Biotechnology,* 3(1), 256-259. http://dx.doi.org/10.22161/ijeab/3.1.32
21. Emmanuel-Ikpene C., Henry, P., Okiri, O.A. (2014). Comparative evaluation of the nutritional, phytochemical and microbiological quality of tree pepper varieties. *Journal of Food and Nutrition Sciences*, 2(3), 74-80. Doi: 10.11648/j.jfns.20140203.1
22. Agrahari, P.R., Thakur, K.S., Shama, R.M., Tripath, V.K. and Singh, R.R. (2001). Effects of various packaging treatments and storage atmosphere on storage quality of chandier strawberry (frangaria x ananassa duch) scientia hat, 7:63-74.
23. Allahraisi, S. (2012). Polypropylene in the industry of food packaging, polypropylene, Dr. Faith Dogan (Ed.) ISBN: 978-953-51-0636-4. Intech, Available from http://www.intechopen.com/books/polypropylene/polypropylene in the industry of food packaging.
24. Espinoza-Atencia, E.J., Faria, J.A.F. & Anjos, C.A.R. (1993). "Efeito de Absorvedor de Ultravioleta em Embalagens de Polietileno Tereftalato para Óleos Comestíveis", In: Anais do 8th IPRI World Conference on Packaging, 2, p.861, São Paulo – SP.
25. Awolaye, W., Maziya-Dixon, B., Alamu, O.E., Menkir, A. (2016). Effect of packaging materials and storage conditions on the degradation of xanthophylls in yellow-maize ogi powder. *Journal of Food and Nutrition Research*, 4(8):522-527.

26. Akhter, S., Anjum, F., Rehman, S.U., Sheikh, M.A. and Farzana, K. (2008). Effect of fortification on physiochemical and microbiological stability of whole wheat flour. *Food Chemistry*, 110(1):113-119.
27. Ogiehor, I.S and Ikenebomeh, M.J (2006). The effects of different packaging materials on the shelf stability of garri. *African Journal of Biotechnology,* 5:2412-2416**.**