American Journal of Engineering Research (AJER) 2015
American Journal of Engineering Research (AJER)
e-ISSN: 2320-0847 p-ISSN : 2320-0936
Volume-4, Issue-9, pp-148-152
www.ajer.org
Research Paper Open Access

The Effect of Packaging Materials on the Quality Attributes of Crayfish During Cold Storage.

Ajala, A.S.,[1] Abiola, T.A.[1]
[1]*Department of Food Science and Engineering, Ladoke Akintola University of Technology, P.M.B. 4000, Ogbomoso, Nigeria*

ABSRACT: *This study evaluates the effects of packaging materials on the quality attributes of crayfish preserved in cold storage. This was done in order to ascertain the suitability of the different packaging materials on keeping the quality attributes of crayfish in cold storage. The "red claw" crayfish was harvested fresh, beheaded, washed, cleaned and packaged in different packaging materials of low-density polyethylene (LDPE), high-density polyethylene (HDPE), aluminum foil and plastic. The crayfish were stored for a period of eight weeks, and samples were taken for analysis every two weeks. The analyses carried out were proximate, mineral (calcium, iron and phosphorus) and microbial (yeast, mould, coliform and total viable counts).*
There were significant reduction changes in the proximate, minerals and microbiological analysis in respect to the packaging materials and storage period.

Key-words: *crayfish, packaging material, quality, cold storage*

I. INTRODUCTION

Crayfish, crawfish or crawdad are freshwater crustaceans resembling small lobsters, to which they are probably closely related. (Hobbs, 1984). Crayfish are eaten in Europe, China, Africa, Australia, Canada, and the United States. Ninety-eight percent of the crayfish harvested in the United States come from Louisiana. Louisiana produces 90 percent of the crawfish in the world and consumes 70 percent locally. (Anderson, 2007).
Food preservation is generally useful and important in ensuring food availability and stability supply all over the world, without these, there might be difficulties arising from food shortage, famine, and a huge downturn in the economy all over the world. To avoid these, food preservation processes must therefore be put in place to ensure adequate food supply, stability and availability. (Bentley and Amy, 2008).
Preservation of crayfish is very paramount because of it is easily susceptible to deterioration immediately after harvest and to prevent economic losses (Okonta and Ekelemu, 2005). According to Akinyele *et al., (*2007), the development of machinery that could be employed for effective handling, harvesting, processing and storage of sea foods such as fish and crayfish cannot be over-emphasized especially when aquaculture is growing fast in Nigeria. Good processing method is achievable by adapting basic parameters of unit operations necessary to achieve quality product which can satisfy the consumers and in turn yields good dividend for the processors. Packaging is an integral part of the crayfish processing as it facilitates handling during marketing and distribution. Song *et al.,* 2009 listed general features of a good packaging material for foods. One of the impediments to the growth of crayfish industries in Nigeria is the lack of adequate packaging technology that could effectively preserve the quality attribute during transportation which has resulted in wastages and poor quality of the available crayfish. Few researchers have worked on preservation and packaging of crayfish, Ajala and Oyategbe (2013) has also published work on the influence of packaging and storage on quality of white shrimp at room temperature. The latest report perhaps on crayfish was from Chen *et al.,* (2007) who worked on crayfish using 3 different packaging systems namely modified atmosphere packaging (MAP), vacuum packaging (VP) and aerobic packaging using polyvinylchloride (PVCP). However, report on effect of packaging materials (such as aluminum foil, low-density polyethylene and high-density polyethylene) on nutritional quality of crayfish at cold temperature has rarely been published. Hence there is a need to evaluating the effects of different packaging materials on the quality attributes and storage life of frozen crayfish. This forms the thrust of the study.

II. MATERIALS AND METHOD

(a) Preparation of the samples:

The fresh crayfish used in this project was obtained from Makoko River in Lagos state, Nigeria. After harvesting, it was immediately put into ice slurry and transported to Food Science and Engineering Department Laboratory, Ladoke Akintola University of Technology, Ogbomoso, Nigeria where it was processed. The process involved beheading and washing. 0.25kg of crayfish was then weighed into each packaging material of sizes (14.5x13.5cm), which included low-density polyethylene (LDPE) of 90 cm^3/cm^2s^{-1} water transmission rate, high-density polyethylene (HDPE) of 41 cm^3/cm^2s^{-1} water transmission rates, Polyvinl Chloride of 275 cm^3/cm^2s^{-1} water transmission rate and aluminum foil. They were then packaged and frozen at -16^0C for 8 weeks at Bol-Raib Investment Nigeria Limited Mega fish cold room, Ogbomoso, Oyo state. At interval of 0, 2, 4, 6 and 8 week; sample pack of crayfish of each packaging materials was removed for mineral, microbial and proximate analyses.

(b) Chemical analysis

Microbial, minerals and proximate analyses were carried out using the official methods of Association of Official Analytical Chemists (AOAC 2000).

(c) Statistical analysis

Data were analyzed using SPSS (version 9.0) package. Analysis of variance was carried out to know the significant effect of the packaging material on the samples. Significant ($P<0.05$) difference between means were identified using the least significant difference procedure.

III. RESULT AND DISCUSSIONS:

(a) Proximate Analysis.

The results obtained from proximate analysis of crayfish stored with different packaging materials are as presented in Table 1. All the samples generally gained moisture in the first two weeks to equilibrate with the surrounding humidity in the freezer, except sample C and D which decreased in moisture content. This could be attributed to the observation of Sing and Heldman 2009 on freezing diagram of food, in which the post cooling enthalphy (which is a function of specific heat and moisture content) decreased for some freezing time. At this time, the moisture content seems decreased due to slight reduction in post cooling enthalphy. However as the weeks increased, all the samples gained a significant amount of moisture, this might be due to their ability to allow moisture transfer across their boundaries. In other word it could be accrued to the nature of the packaging material in which transfer of water and oxygen is possible as reported by (Potter and Hotchkiss, 2006). It is observed from the table that sample at 8^{th} week recorded highest value of moisture which implies that the higher the storage time, the higher the moisture content of the frozen crayfish samples. This observation has been earlier asserted by other authors such as Ajala and Oyategbe (2013), Akintola and Bakare (2012), Joseph *et al.*, (1998), Basavacumer *et al.*, 1998

The protein content decreased generally as the storage days increased. However, sample C had the highest protein content present at the end of 8^{th} week meaning the packaging material retained the protein content better and was significantly different from the other packaging materials, however sample B had the lowest protein content and was also significantly different from other samples. The major loss of protein in sample B was as a result of leakages of protein content from the packaging material. This is a similar finding to the work of Gong *et al.*, (2010) in which there was reduction in protein content of red claw crayfish packaged with polyethylene stored at -20^0C.

The percentage range of the fat content is in agreement with work of Nahid and Fayza, (2009) with values of 2.45 %. However, the results showed that crayfish samples were generally low in fat contents as earlier reported by Chien *et al.*, (2007). As the storage days increased, there were reductions in fat contents in all the samples.

Table 1: Results of proximate composition

Samples	Fresh (0 Week)	2 Weeks	4 Weeks	6 Weeks	8 Weeks
		Moisture contents (%)			
A	$72.37^a \pm 0.69$	$74.17^a \pm 0.15$	$75.83^a \pm 0.15$	$77.70^a \pm 0.20$	$78.33^a \pm 0.15$
B	$72.37^a \pm 0.69$	$74.13^a \pm 0.06$	$75.86^a \pm 0.06$	$77.73^a \pm 0.15$	$78.93^a \pm 0.06$
C	$72.37^a \pm 0.69$	$67.83^c \pm 0.11$	$70.00^c \pm 0.10$	$71.73^c \pm 0.38$	$74.67^c \pm 0.15$

D	72.37^{a} ±0.69	69.87^{b} ±0.06	72.57^{b} ±0.30	74.53^{b} ±0.21	75.43^{b} ±0.15
		Protein contents (%)			
A	20.47^{a} ±0.39	17.90^{c} ±0.10	18.27^{c} ±0.15	18.43^{c} ±0.11	18.47^{c} ±0.06
B	20.47^{a} ±0.39	17.30^{d} ±0.17	17.53^{d} ±0.06	17.63^{d} ±0.06	17.77^{d} ±0.11
C	20.47^{a} ±0.39	18.47^{a} ±0.15	18.90^{a} ±0.10	18.97^{a} ±0.06	19.03^{a} ±0.15
D	20.47^{a} ±0.39	18.27^{b} ±0.06	18.50^{b} ±0.10	18.67^{b} ±0.06	18.77^{b} ±0.06
		Fat contents (%)			
A	3.87^{a} ±0.14	1.27^{c} ±0.11	1.20^{b} ±0.10	1.27^{b} ±0.06	1.23^{c} ±0.05
B	3.87^{a} ±0.14	1.27^{c} ±0.06	1.23^{b} ±0.06	1.27^{b} ±0.06	1.27^{c} ±0.06
C	3.87^{a} ±0.14	1.53^{b} ±0.06	1.57^{a} ±0.06	1.60^{a} ±0.00	1.63^{b} ±0.06
D	3.87^{a} ±0.14	1.67^{a} ±0.06	1.60^{a} ±0.10	1.67^{a} ±0.06	1.73^{a} ±0.11
		Ash contents (%)			
A	3.10^{a} ±0.14	1.93^{c} ±0.06	1.83^{c} ±0.11	1.83^{c} ±0.05	1.80^{c} ±0.10
B	3.10^{a} ±0.14	1.77^{d} ±0.12	1.70^{d} ±0.10	1.73^{d} ±0.06	1.83^{c} ±0.06
C	3.10^{a} ±0.14	2.10^{a} ±0.10	1.97^{a} ±0.12	2.00^{a} ±0.10	2.17^{a} ±0.06
D	3.10^{a} ±0.14	2.07^{b} ±0.06	1.87^{b} ±0.06	1.90^{b} ±0.00	1.97^{b} ±0.06
		Fibre contents (%)			
A	0.10^{a} ±0.00	0.10^{a} ±0.00	0.10^{a} ±0.00	0.10^{a} ±0.00	0.10^{a} ±0.00
B	0.10^{a} ±0.00	0.07^{b} ±0.06	0.10^{a} ±0.00	0.10^{a} ±0.00	0.10^{a} ±0.00
C	0.10^{a} ±0.00	0.10^{a} ±0.00	0.10^{a} ±0.00	0.10^{a} ±0.00	0.10^{a} ±0.00
D	0.10^{a} ±0.00	0.07^{b} ±0.06	0.07^{b} ±0.06	0.07^{b} ±0.06	0.03^{b} ±0.06
		Carbohydrate contents (%)			
A	0.10^{a} ±0.00	0.17^{b} ±0.01	0.90^{d} ±0.00	0.57^{d} ±0.15	0.23^{a} ±0.04
B	0.10^{a} ±0.00	0.13^{a} ±0.01	0.70^{c} ±0.20	0.40^{c} ±0.10	0.90^{c} ±0.10
C	0.10^{a} ±0.00	0.13^{a} ±0.02	0.73^{b} ±0.16	0.33^{b} ±0.12	0.23^{a} ±0.05
D	0.10^{a} ±0.00	0.17^{b} ±0.02	0.47^{a} ±0.11	0.13^{a} ±0.03	0.63^{b} ±0.15

Means with the same letter across the column are not significantly different,
Codes: A- Low-density polyethylene, B- High-density polyethylene, C- Aluminum foil, D- Plastic

However, samples C and D were able to retain fat content more than the other samples A and B, this is because perhap sample A and B allowed oxidation to take place than sample C and D; this is similar to the work of Kong *et al.*, (2006). Samples C and D were able to form a good barrier against light and other factors which could cause oxidation.

The ash content decreased generally as storage time increased, this is an obvious reason of leakages of minerals as storage days increased. This observation is in line with the work of Ibrahim and El-Sherif (2008). The ash content was highest in sample C and least in sample A, and they were significantly different from each other. Sample C and D had higher ash contents than samples A and B; this might be because the packaging materials of A and B allowed more mineral loss sample C and D.
The results of fibre content show that crayfish is poor in fibre as its values range from 0.03- 0.1%. Virtually, the fibre content remained constant during the storage period which means the fibrous particles of the crayfish were greater than pore sizes of the packaging material hence the fibre were retained.
The carbohydrate results are as shown in Table 1. The least value of carbohydrate at the 8th week is found in sample A while the highest value is found in sample C. The samples are significant from each other. All the samples increased in values as storage days increased. The trend in increment in these values was as result of either increase or decrease in value of other parameters such as moisture, protein, fat, fibre and ash because carbohydrate is a percentage difference from addition of these parameters.

(b) Mineral analysis
The results obtained from the mineral analysis of the samples stored with different packaging materials are presented in Table 2. Sample D had the highest retention of calcium present followed by samples C while sample A has the lowest value. There was significant difference among all the samples at the second week of the storage but as storage days increased from 4th to 8th, Sample A and B were not significantly different but they were significantly different from sample C and D. The same trend was observed in iron and phosphorus content. There was a general minimal loss of mineral content of the samples through the packaging materials during storage. In a nut-shell, as the cold storage days increased, the values of minerals decreased. Similar observation has been earlier reported by other researchers such as Ajala and Oyategbe (2013); Nahid and Fayza (2009), Cemal Kaya (2011).

Table 2: Results of mineral content variation during the storage

Samples	Fresh (0 Week)	2 Weeks	4 Weeks	6 Weeks	8 Weeks
		Calcium (mg / 100 g wet sample)			
A	215 ±2.45	211.00^{c} ±3.00	211.00^{b} ±3.00	210.33^{b} ±1.53	207.00^{b} ±1.73
B	215 ±2.45	213.67^{b} ±1.15	212.67^{b} ±1.15	211.87^{b} ±0.58	209.67^{b} ±0.58
C	215 ±2.45	214.00^{a} ±3.61	214.67^{a} ±3.51	213.67^{a} ±3.21	211.33^{a} ±3.79
D	215 ±2.45	215.33^{b} ±2.52	214.33^{a} ±2.52	213.33^{a} ±2.31	211.67^{a} ±3.06
		Iron (mg / 100 g wet sample)			
A	1.70 ±0.00	1.70^{b} ±0.00	1.70^{b} ±0.00	1.70^{b} ±0.00	1.70^{b} ±0.00
B	1.70 ±0.00	1.73^{b} ±0.06	1.73^{b} ±0.06	1.73^{b} ±0.06	1.73^{b} ±0.06
C	1.70 ±0.00	1.77^{a} ±0.06	1.80^{a} ±0.00	1.80^{a} ±0.00	1.80^{a} ±0.00
D	1.70 ±0.00	1.87^{a} ±0.06	1.87^{a} ±0.06	1.87^{a} ±0.06	1.87^{a} ±0.06
		Phosphorus (mg / 100 g wet sample)			
A	208.67^{a} ±2.31	208.33^{a} ±2.89	207.67^{a} ±1.69	207.67^{a} ±2.52	207.67^{a} ±2.52
B	209.33^{a} ±3.06	209.00^{a} ±3.61	209.00^{a} ±3.61	207.67 ±1.69	207.33^{a} ±5.03
C	208.67^{a} ±3.06	207.67 ±1.69	207.33^{a} ±3.06	205.67^{a} ±4.16	204.00^{a} ±3.61
D	207.67 ±1.69	199.67^{b} ±4.04	198.67^{b} ±7.57	197.33^{b} ±6.43	197.33^{b} ±6.43

Means with the same letter across the column are not significantly different,

Codes: A- Low-density polyethylene, B- High-density polyethylene, C- Aluminum foil, D- Plastic

The results of the microbial analysis of the samples stored with different packaging materials are presented in Table 3. The values of mould and yeast count in this work are greater than the values reported by Emad *et al.*, (2012) with value of $3.12x10^{2}$ and $4.1\ x10^{2}$ respectively. Also the values of both coliform and total viable count in this work are greater than the values reported by the same author. The difference in values may be as a result of species variety and primarily aquatic habitat factor. From the table total viable count was initially high in all the samples but later there was a general trend in reduction of yeast, mold, coliform and total viable count as storage days increased. The obvious reason for this could be because of low storage temperature effect on these microorganisms. Most of these microbes are mesophile which cannot withstand cold temperatures irrespective of the packaging materials. Therefore, lower temperature served as a critical factor in inhibiting the growth of these microbes as reported by Chien *et al.*, (2007), Potter and Hotchkiss, (2006).

IV. CONCLUSION

In summary, the fresh sample analyzed was quite better than the stored samples because finding shows a decrease in the quality attributes of the crayfish, these differences were however not pronounced to cause any devastating effect on the quality attributes of the crayfish. The results of the proximate, microbial and mineral analyses show that aluminum foil was better rated than other packaging material from microbiological standpoint. This implies that samples stored with aluminum foil formed effective barrier against chemical and biological changes on the crayfish than samples stored with the other packaging materials. However, aluminum foil is cost ineffective compare to others; hence the decision for packaging material for crayfish is left to individual crayfish processor

Table 3: Results of Microbial analysis during the storage

Samples	Fresh (0 Week)	2 Weeks	4 Weeks	6 Weeks	8 Weeks
		Yeast count (cfu/ml)			
A	$5.17x10^{6}$ ±136	780^{d} ±189	0.00 ±0.00	0.00 ±0.00	0.00 ±0.00
B	$5.17x10^{6}$ ±136	105^{a} ±18	0.00 ±0.00	0.00 ±0.00	0.00 ±0.00
C	$5.17x10^{6}$ ±136	401^{c}±20	0.00 ±0.00	0.00 ±0.00	0.00 ±0.00
D	$5.17x10^{6}$ ±136	143^{b} ±19	0.00 ±0.00	0.00 ±0.00	0.00 ±0.00
		Mould count (cfu/ml)			
A	$6.05x10^{4a}$ ±19	0.00 ±0.00	0.00^{a} ±0.00	0.00^{a} ±0.00	0.00 ±0.00
B	$6.05x10^{4a}$ ±19	30^{a} ±18	20^{b} ±05	0.00^{a} ±0.00	0.00 ±0.00
C	$6.05x10^{4a}$ ±19	0.00 ±0.00	0.00 ±0.00	0.00^{a} ±0.00	0.00 ±0.00
D	$6.05x10^{4a}$ ±19	0.00 ±0.00	0.00 ±0.00	0.00^{a} ±0.00	0.00 ±0.00
		Coliform count (cfu/ml)			
A	$3.02x10^{4a}$ ±89	102^{c} ±29	0.00 ±0.00	0.00 ±0.00	0.00 ±0.00
B	$3.02x10^{4a}$ ±89	0.00 ±0.00	0.00 ±0.00	0.00 ±0.00	0.00 ±0.00
C	$3.02x10^{4a}$ ±89	101^{b} ±24	0.00 ±0.00	0.00 ±0.00	0.00 ±0.00

D	$3.02x10^{4a}$ ±89	202^{a} ±69	102^{c} ±59	0.00 ±0.00	0.00 ±0.00
	Total viable count (cfu/ml)				
A	$6.17x10^{6}$ ±147	890^{a}±85	0.00±0.00	0.00 ±0.00	0.00 ±0.00
B	$6.17x10^{6}$ ±147	150^{c}±37	29±06	0.00 ±0.00	0.00 ±0.00
C	$6.17x10^{6}$ ±147	120^{d}±23	0.00±0.00	0.00 ±0.00	0.00 ±0.00
D	$6.17x10^{6}$ ±147	350^{b}±63	130±13	0.00 ±0.00	0.00 ±0.00

Means with the same letter across the column are not significantly different,

Codes: A- Low-density polyethylene, B- High-density polyethylene, C- Aluminum foil, D- Plastic

REFERENCES

[1] Ajala and Oyategbe (2013). Influence of Packaging and Storage on Nutritional Quality of White Shrimp (Penaeus vannamei), International Journal of Advanced Scientific and Technical Research. Issue 3 volume 2, pp 232-235

[2] Akintola, S.L. and Bakare, S.B. (2012). Effect of ice storage on the biochemical composition of Macrobachium vollenhovenii. Journal of Fishery and Aquatic Science, pp 1-5

[3] Anderson, O.E (2007) Refrigeration in America. Port Washington, N.Y Kennikat Press. Pg 203-208.

[4] AOAC (2000). "Official Methods of Analysis (16th edn). Association of Official Analytical Chemists". Virginia, USA, pp. 834 - 841.

[5] Basavacumer, K.V., Bhaskar, N., Ramesh, A.M. and Reddy, G.S.V. (1998). Quality change in coloured tiger shrimps during ice storage. Journalof Food Science and Technology, 35:305-309

[6] Bently O and Amy F (2008). Eating for victory: Food rationing and the politics of Domesticity. Page 14-21.

[7] Cemal K.(2011). Effects of different phosphorus doses on the physico-chemical properties of strawberry during storage. Journal of Food, Agriculture & Environment Vol.9 (2): 106-109

[8] Chen, G., Xiong, Y.L., Kong, B., Newman, M.C., Thomson, K.R., Metts, L.S. and Webster, C.D. (2007). Microbiological and physicochemical properties of red claw crayfish (Cherax quadricarinatus) stored in different package systems at 2◦C. Journal of Food Science—Vol.72, No 8, pp 442-445

[9] Emad M. E., Seham A. K. and Mohammed, A. T. A. (2012). Chemical, physical, microbiological and quality attributes studies on River Nile crayfish. African Journal of Biotechnology Vol. 11(51), pp. 11262-11270.

[10] Gong YN, Li WW, Sun JL, Ren F, He L, Jiang H et al.(2010).Molecular cloning and tissue expression of the fatty acid-binding protein (Es-FABP) gene in female Chinese mitten

[11] crab (Eriocheir sinensis).BMC Molecular Biology 11: 71.

[12] Ibrahim, S. M. and El-Sherif, S. A. (2008) Effect of some plant extracts on the quality aspect of frozen Tilapia (Oreochromisniloticus L.) fillets. Global Vetrinaria 2:2:62-66

[13] Joseph, J., Jerrygreen, P.A. and Gopalakrishna, T.S. (1998). Storage characteristics of cultured Pennaeus indicus in ice and at ambient temperature. Fish Techn. 35: 84-89

[14] Nahid F.Z. and Fayza, E. (2009). Study on chemical Quality and Nutrition Value of Fresh Water Cray Fish (Procambarus clarkii). Journal of the Arabian Aquaculture Society, vol. 4, No 1, pp1-6

[15] Okonta, A. A. and Ekelemu, J. K. (2005), A preliminary study of micro-organisms associated with fish spoilage in Asaba, Southern Nigeria. Proceedings of the 20th Annual Conference of the Fisheries Society of Nigeria (FISON), Port Harcourt, Nigeria. pp557 – 560

[16] Potter H, Hotchkiss I (2006). Food Science. (5th ed.). CBS Publishers and Distributors. New Delhi, India

[17] Singh Paul R. and Heldman Dennis R.. (2009). Introduction of Food Engineering. 4th Edition: Academic Press, Incorporated. Chapter 7, Pp 503-507

[18] Song, J. H., Murphy, R. J., Narayan, R. and G. B. H. Davies (2009). Biodegradable and compostable alternatives to conventional plastics. Phil. Trans. R. Soc. B. 364, 2127–2139