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Effects of preservatives on the shelf life of *Chrysophyllum albidum* fruits

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Abstract

Food preservation involves putting microorganisms in a hostile environment in order to inhibit their growth or shorten their survival or cause their death. It is an age long technique that helps to prevent food spoilage and ensures continuous food availability. *Chrysophyllum albidum* (African star apple) plantsand fruits have high economic, medicinal and nutritional values. This study focused on the use of chemical and natural preservatives to enhance the shelf life of *C. albidum* fruits. The chemical preservative used was sodium carbonate while the natural preservatives were *Chrysophyllum albidum* oil and coconut oil.Results showed mean to total bacterial and fungal counts in the range 1.0± 1.00 x 10^7 cfu/g to6.0± 1.00 x 10^7 cfu/g and 4.0± 1.00 x 10^7 sfu/g to 9.7± 0.88 x 10^7 sfu/g respectively. The lowest counts were observed in samples preserved with 0.5% sodium carbonate (chemical preservative) and *Chrysophyllum albidum* oil but with no significant difference ($P \leq 0.05$). This study revealed that the chemical and natural preservatives (sodium carbonate, *Chrysophyllum albidum* oil and coconut oil) used in this study can extend the shelf life from the average of 5 days to 11 days. The used of natural preservatives to extent the shelve life of fruitsis strongly advocated because of the possibility of alteration of its organoleptic properties and nutrient composition by chemical preservatives.

Keywords: Natural and chemical preservatives, *Chrysophyllum albidum* fruit, shelve life, bacterial and fungal counts

INTRODUCTION

Food preservation is an age long technique used to enhance food shelf-life. It is an important component of food industry that helps to prevent food spoilage and ensures continuous food availability (Msagati, 2012).

Preservatives are chemical substances that are added to foods to deter unwanted microbial activity. Many food products are perishable by nature and require protection from spoilage during their preparation, storage and distribution to give them the desired shelf-life (Shaw and Ian, 2012). Food preservation involves putting microorganisms in a hostile environment in order to inhibit their growth or shorten their survival or cause their death. The responses of the microorganisms to such hostile environment determines whether they may survive or die (Leistner, 2000). Food products are now being sold in areas of the world far distant from their production sites,

therefore, there is need for extended shelf-life of these products.

The *Chrysophyllum albidum* (African star apple) has far-reaching economic values ranging from its medical properties to nutritional uses. The African star apple is an important medicinal plant used as remedy for yellow fever and malaria (Egunyomi *et al*., 2005). Its medicinal properties lies mainly on the leaves and bark of the tree. Other medicinal benefits include lowering of plasma cholesterol level, reduce rate of sugar uptake, its detoxifying action and effectiveness in diarrhea treatment (Egunyomi *et al.*, 2005). The fruit has high vitamin C and iron contents. Despite the diverse benefits, the fruits waste away shortly after dropping from the tree due to its transient shelf-life. Amusa *et al*., 2003 opined that more than thirty (30) percent post harvest losses of African star apple was recorded within a period of five (5) days due to high tropical temperature, humidity, poor handling practices and lack of processing and preservative techniques. To prevent these losses, there is urgent need to investigate better methods of preserving this premium fruit, African star apple.

Intelligent selection and combination of different preservative could be an option for enhancing the shelf-life of *Chrysophyllum albidum*fruits. An intelligent combination of different preservatives in food hit different targets (cell membrane, DNA and enzyme system) within the microbial cell and thus disturb the physiology of the microorganisms. By this, the microorganism use up its energy, become metabolically exhausted and die, thereby resulting in an auto-sterilization of the food product (Leistner, 1992). Examples of chemical preservatives that could be used for the preservation of *Chrysophyllum albidum* include; benzoates, nitrites, sulphites, sorbates etc. These techniques are directed towards reducing the risk and outbreak of food poisoning, and microbial deterioration (Dalton, 2012). One of the pitfalls of these preservatives is their ability to alter the organoleptic properties and nutrient composition of the food. For example, refrigeration alone cannot assure the safety and quality of perishable foods.Also, some organism escape the hurdles of some of the chemical preservatives thereby making the whole efforts ineffective (Msagati, 2012).

Over the years, little attention has been given to the preservation of *Chrysophyllum albidum* fruits. This results in the under-exploitation and under-utilization of the nutritional benefits and medical properties of the African star apple.

Several researchers (Adewusi, 1997; Adisa, 2000; Amusa *et al*., 2003; Egunyomi*et al*., 2005; Akubugwo and Ugbogu, 2007; Ugbogu and Akukwe, 2008; Edem and Miranda, 2011; Oboh *et al*., 2009; Adebayo*et al.*,2010 and Adeoye, *et al*., 2010) have reported the nutritional, phytochemcal and medicinal importance of *Chrysophyllum albidum.* But little has been done on the preservation of these edible fruits and this has hampered its long-term availability. This research focuses on preservation of *C. albidum* fruits using natural and chemical preservatives.

MATERIALS AND METHODS

Sources and collection of Samples

Samples were collected from different trees located at Opoji village, Esan West Local Government Area, Edo State. The samples that dropped from trees over the night were the ones collected in the morning. Samples were immediately transported to Ambrose Alli University laboratory for analysis.

Sample Treatment and Enumeration of Associated Microorganisms at two days interval for 11 days

The samples were surface sterilized in 2% aqueous solution of commercial bleach (sodium hypochlorite) for 2mins, followed by further treatment in 75% ethanol for another 2mins and then rinsed in two sequence of changed autoclaved distilled water. Samples were then separated into four groups (A, B, C and D) of 10 fruits each in triplicates. Group A was without any substance rubbed on it (control), group B was with *C. albidum* oil, group C with coconut oil rubbed on it and group D had 0.5% Sodium carbonate (a chemical preservative) rubbed on it. Representative fruits from each group at day 1 were dissected into pieces with sterile cutting blades and 20g each was transferred into 180ml of sterile quarter strength Ringer's solution. The solution and its content was periodically agitated to homogenize and left to stand for 2 hours after which the content was serially diluted and aliquot of 0.1 ml separately plated on Nutrient Agar (NA) and Sabouraud Dextrose Agar (SDA) using the pour plate method. All experiments were done in triplicates and NA plates were incubated at 37^{o}C for 24 hours whereas SDA plates were incubated at ambient temperature (28 ± 2^{o}C) for 48 hours. Discrete colonies of bacteria were observed, counted and recorded as colony forming unit per gram (cfu/g) while the fungal colonies were counted and recorded as spore forming unit per gram (cfu/g). This process was repeated for the different sampling days.

RESULTS AND DISCUSSION

The effects of preservatives on *ChrysophylIum albidum* was studied to determine the effectiveness of natural and chemical preservatives on the edible fruits. Analyses carried out included total heterotrophic bacterial and fungal counts on fruits treated with different preservatives.

The results of microbial load of *ChrysophylIum albidum* fruits with and without preservatives are shown in Tables 1 and 2 below.

Table 1 showed the mean total viable heterotrophic counts of bacteria on*ChrysophylIum albidum* fruits on the respective sampling days. The lowest count of $1.0\pm1.00x10^{7}$cfu/g was recorded for Group D on Day 11 while the highest count ($4.7\pm1.00x10^{7}$cfu/g) occurred on Day 0-1 Group C. In total heterotrophic bacterial count, there was no significant difference ($0\leq0.05$) in count between the unpreserved group A and the preserved groups B, C and D on Day 0-1. This may be due to the fact that the preservatives applied to the fruits required time to exert their effects on bacterial cell inactivation or lysis. Usually cells try to instantaneously adapt or employ various mechanisms to circumvent antimicrobial agent after which they either become successfully resistant or get destroyed. Also time is required to build up the microbial load on the fruit after the initial thorough washing (Adindu*et al*., 2003; Kehinde and Ikenga, 2010; Arotupin*et al*., 2016). On day 3 and 5, the bacterial counts decreased in groups B, C and D but increased in group A (control). Deterioration of the fruit was observed on group A on day 6. This could be linked to the increase in the bacterial load. The bacterial load on the experimental groups decreased steadily day 7 to 11. This pattern of decrease may be attributed to the effect of the preservatives on the fruits which is agreeable with results obtained by Adindu*et al*., (2003) in which application of chemical preservatives prolonged the storage time or shelf-life of the *C. albidum* fruit for up to day 10 before observable deterioration set in. Except on Day 0-1, there was significant difference ($P\leq0.05$) in count between the unpreserved group A (control) and the preserved groups

B, C and D throughout the sampling periods. The rate of deterioration of fruits and food products depend largely on the microbial load and types of microorganism proliferating or sporulating in the product especially owing to their ubiquity. The results of the total viable heterotrophic bacterial count (Table 1) shows that at time 0-24 hours, the microbial count was $4.7\pm0.67\times10^7$ cfu/g as shown by the experimental group A which increased on day 3 ($5.6\pm0.58\times10^7$ cfu/g) and day 5 ($6.0\pm1.00\times10^7$ cfu/g) due to rapid increase in bacterial count. On day 7, 9 and 11, bacterial count decreased steadily to $4.3\pm0.88\times10^7$cfu/g, $3.6\pm0.58\times10^7$cfu/g and $3.0\pm0.50\times10^7$cfu/g respectively. This result conforms with that reported by Oranusi*et al*., (2015) in which the bacterial count increased from 1.0×10^7 cfu/g to 2.0×10^7 cfu/g, 4.3×10^7 cfu/g, 6.5×10^7 cfu/g, corresponding to day 1, 2, 3, 4, and started decreasing to 3.0×10^7 cfu/g, 3.1×10^6 cfu/g and 2.0×10^6 cfu/g corresponding to day 8, 9 and 10 respectively. This microbial count pattern of group A (control) is typical of bacterial cells which find their way into a nutrient rich fruit or medium in which the cells experience a lag growth phase which is immediately preceded by exponential growth phase due to availability of nutrient and then, on day 7, the depletion of nutrient in the medium began to limit cell proliferation, leading to decreased bacteria count, observed for day 9 and day 11.

Table 2 showed the mean totalheterotrophic fungal count on the fruits during the study period. The lowest fungal counts ($4.0\pm1.00x10^7$cfu/) for the preserved groups B, C and D occurred on Day 7 group D while the highest count ($7.2\pm1.20x10^7$cfu/ml) for the preserved groups B, C and D was recorded on Day 0-1 group C. The lowest count ($7.2\pm0.50x10^7$cfu/ml) for the unpreserved group A (control) was recorded on Day 11 while the highest count ($9.7\pm0.88x10^7$cfu/ml) occurred on Day 9. There was no significant difference ($P\leq0.05$) in the heterotrophic fungi count between the unpreserved group A and the preserved groups B, C and D on Day 0-1. Also, there was no significant difference ($P\leq0.05$) in count among the preserved groups B, C and D on Day 9 and 11. Fluctuated values were obtained on day 7 among the preserved groups.

Table 1: Total viable heterotrophic bacterial counts of *C. albidum* fruits(mean ± SE× 10^7 cfu/g)

Days	Group A (control)	Group B	Group C	Group D
0-1	4.7^a ±0.67	4.6^a± 1.20	4.7^a± 1.00	4.4^a± 0.50
3	5.6^a ± 0.58	4.3^c± 0.88	4.0^b± 0.58	4.0^b± 0.67
5	6.0^a± 1.00	4.0^c± 0.58	4.3^c± 0.50	3.3^b± 0.58
7	4.3^a ± 0.88	3.3^b± 0.33	3.3^b± 0.88	3.0^c± 1.20
9	3.6^a ± 0.58	2.0^b± 0.50	3.0^c± 0.67	2.7^c± 0.32
11	3.0^a ± 0.50	1.2^b± 0.32	1.7^c± 0.43	1.0^b± 1.00

Results are the mean ± SE value of triplicate determinations. Rows with the same superscript are not significantly different ($p\leq 0.05$)

Keys: SE = Standard Error

Group A = Fruit only; Group B = Fruit + *C. albidum*oil; Group C = Fruit + Coconut oil;Group D = Fruit + 0.5% Sodium carbonate

Table 2: Total fungal count of *C. albidum* fruit(Mean ± S.E × 10^7 sfu/g)

Days	Group A (control)	Group B	Group C	Group D
0-1	7.3^a ± 0.87	7.0^a± 0.50	7.2^a± 1.20	7.2^a± 0.58
3	8.6^a ± 0.33	5.7^a± 1.00	6.0^b± 0.50	5.3^c± 0.20
5	8.7^a ± 1.20	4.6^b± 0.37	5.3^c± 0.50	4.7^c± 0.88
7	9.0^a ± 0.38	4.6^b± 0.68	5.7^a± 0.88	4.0^b± 1.00
9	9.7^a ± 0.88	6.6^b± 1.33	6.7^b± 0.67	6.3^b± 0.33
11	7.2^a± 0.50	4.3^b± 0.42	4.6^b± 0.43	4.5^b± 0.50

Results are the mean ± SE value of triplicate determinations. Rows with the same superscript are not significantly different ($p \leq 0.05$)

Keys: SE = Standard Error
Group A = Fruit only; Group B = Fruit + *C. albidum*oil; Group C = Fruit + Coconut oil; Group D = Fruit + 0.5% Sodium carbonate

CONCLUSION

The research has shown that application of preservatives to *Chrysophyllumalbidum* has proven effective in enhancing its shelf-life. Lower microbial counts were observed among the samples applied with preservatives compared to the group without any preservative. Also, the chemical preservative (sodium carbonate) usedwas more potent than the natural ones (coconut oil and *C. albidum* oil) used. The preservatives reduced the bacteria and fungi loads with concomitant delayin microbial deterioration of the fruits.

Single and intelligent combination of chemical preservatives could open a new dimension in enhancing the shelf-life of African star apple. The shelf-life of *C. albidum* could also be enhanced by maintaining hygienic practices beginning from harvesting. The fruits should be harvested in clean, food-grade carrier bags free from contamination and stored in a cool dry place. This will help to eliminate unwanted contaminants and reduce microbial growth. Also, the preservatives should be carefully selected to ensure the organoleptic properties and the nutrients present in the fruit are not jeopardized. The selected preservatives should not pose health problems to the consumers. Therefore, the preservatives should be minimally combined as consumers now prefer natural and preservative-free foods to processed ones.

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