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308 Lasani Town, Sargodha Road, Faisalabad - Pakistan
Mob: +92 300 3008585, Fax: +92 41 8815544
E-mail: editorpjn@gmail.com

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Effect of Different Waxing Material on Some Chemical Properties, Minerals and Antinutrients Compositions of Pawpaw (*Carica papaya*)

W.A. Oyeleke and J.O. Odedeji
Department of Food Technology, Osun State Polytechnic, P.M.B. 301, Iree, Nigeria

Abstract: The effects of using palm kernel, honey and chemical waxes on some chemical properties, minerals and antinutrients compositions of pawpaw fruits stored for a period of weeks were investigated. Pawpaw fruits used for this study were obtained from a local farm at Aagba, in Boripe Local Government Area of Osun State, Nigeria. The fruits were grouped into four. Three of them were differently treated with each of the three waxes (palm kernel honey and chemical) using cold or dipping wax method while the fourth group served as control sample. The four samples were then stored under the same conditions of storage for a period of four weeks at the end of which they were evaluated for their chemical properties, mineral composition and antinutrients using the standard methods. The chemical analysis gives the pH (5.38±0.02 - 5.91±0.02), Reducing sugar (5.32±0.02 - 6.40±0.03) and vitamin C (22.60±0.05 - 27.80±0.05). The mineral analysis gives potassium (171.60±0.4 - 198.70±0.6), Phosphorus (148.70±0.3 - 161.70±0.4) and Iron (0.45±0.004 - 0.64±0.005). The antinutrients composition gives tannin (0.118±0.002 - 0.124±0.002), Saponin (0.500±0.005 - 0.530±0.005) and morphine alkaloid (1.400±0.005 - 1.540±0.006). The three waxes (palm kernel, honey and chemical) brought about decrease in the chemical properties, minerals and antinutrients compositions of pawpaw fruits. Pawpaw sample treated with honey wax retained chemical properties and mineral compositions relatively higher than other waxing methods while the antinutrients components were reduced to the bearest minimum. However, the pH is better retained using the palm kernel wax.

Key words: Waxing, chemical properties, antinutrients, mineral

INTRODUCTION

Preservation is a process through which a product or food material is subjected to certain processes through which their original state is maintained without any deterioration in quality over a period or length of time. The principle behind preservation of food crops is to prevent or reduce the activities of the microorganisms in the food. This can be achieved by depriving the microorganisms the necessary conditions or materials that are required for production or multiplication, which results in spoilage. The conditions include the temperature of the medium, the concentration of the medium, while the materials include the presence of water, oxygen, nutrient in green plant, sunlight and the release of carbon-dioxide. The absence of one or two of the conditions or materials will either result in non-materials will either result in non-multiplication or slow multiplication of the microorganisms.

The life of many foods may be increased by storage at temperature below -4^{o}C. The principle behind this method is that water is not made available to the microorganisms by converting them to ice-blocks with the use of low temperatures method and thus reduces the activities of the microorganisms which in turn retards spoilage. Commonly refrigerated foods include fresh, fruits and vegetables, eggs, dairy products and meats. Some foods such as tropical fruits are damaged if exposed to low temperatures. Also, refrigeration cannot improve the quality of decayed food, it can only retard deterioration. Since low temperature storage causes the degradation of the cell wall during thawing and processing, the need for an effective way of extending the shelf life of fruits prompted scientists venturing into the use of wax in shelf-life extension which does not affect both the cell wall and its nutrients. In recent years much attention has been paid to explore the potential of surface coating to maintain the quality of harvested fresh produce and to reduce the volume of disposable non-biodegradable packaging materials. Many fruits develop a waxy coat on their epidermis as they mature on the plant (apples, bananas, mangoes and grapes). They develop a waxy coating on the epidermis which either felt or seen as a powdering coat, wax usually develops when the fruit has attained two-thirds of its growth. But much as extraneous matter and spray residues. The natural waxy coat is not adequate to offer protection against water loss and high respiration rate. Thus the approach towards prolonging the life of fruits and vegetables involves restricting the rate of respiration and preventing moisture loss, so as to maintain quality as in the freshly picked fruit or vegetable.

Preservatives and antioxidants may be incorporated into some food products to extend their shelf-life some companies use induction sealing and vacuum pouches

Corresponding Author: W.A. Oyeleke, Food Technology Department, Osun State Polytechnic, P.M.B. 301, Iree, Nigeria

to assist in the extension of the shelf life of their products. Some degradation factors can be controlled by the use of appropriate packaging, for example the amber bottle used for many beers blocks damaging wave lengths of light. Transparent beer bottles do not packaging with barrier materials e.g. low moisture, vapour transmission rate, etc extends the shelf life of some foods (Cohen Laurie, 2000).

Some tropical fruits are well known all over the world. Pomegranates, mangoes, papayas, avocadoes (alligator pears), bananas, pineapples, guavas, star fruits (carambolas), kiwis, dates and passion fruit are some examples of well known tropical fruits. In fact, the bananas is one of the highest selling fruits around the world. Many of these fruits are available in big markets year-round due to the steady supply of fruits from the tropics. Other tropical fruits cultivars are more obscure. While they may be popular in specific regions of the world, they are not familiar to people outside of these areas and some of them are definitely have an acquired taste. Some more obscure examples of tropical fruits include soursorps, cherimoyas, sugar apples, jade fruits, pawpaw, duvian, acerolas, mamey, alcee, breadfruit, lychees. Some of these fruits like jack fruit and durian are infamous for their strong odour and flavour, while others luke mangosteen, lychees and cherimoyas are quite simply, delicious but difficult to cultivate making it hard to promote them (Bello *et al.*, 2008).

Most tropical fruits are seasonal and highly perishable. They include oranges, pineapple, mangoes, pawpaw (papaya), cashew fruit to mention few. Once harvested they continue to respire rapidly and lose moisture through transpiration because of the tropical atmospheric conditions (high temperature and low relative humidity). This implies physiological stress and accelerates a biochemical reaction that speeds up deterioration in the fruit. Tropical fruits which have high nutritional and medicinal values are very seasonal and deteriorate speedily shortly after harvest. This situation needs to be reduced or prevented using suitable storage techniques, packaging materials that are appropriate chemical treatments, controlled atmosphere, etc are known methods for extending the shelf and storage life of fruits particularly in developed countries. These were continually being tested to investigate how suitably they could be adopted in developing countries to store tropical fruits in order to reduce their wastage. There is scarcity of technologically suitable and economically, feasible methods of preserving fruits in their fresh form in the tropics resulting in their seasonal glut (i.e. the fruits are readily available at rock bottom prices during their seasons with high attendant wastage and becomes terribly scarce and expensive shortly after their season). Therefore, efforts are being intensified to improve on the methods available for extending both the shelf life and the storage life of fruits through refrigeration regulation and modification of the storage atmosphere (CAS), packaging in plastic films, use of food surface coatings e.g. wax, chemical treatment and from the reasons a aforementioned that, besides packaging the fruits in plastic films and application of food surface coatings with some chemical impregnation which can only extend shelf life/storage life for few weeks, the most feasible approach would be to process them into juices and move/stable products i.e. jams and jellies.

The principle involved during storage of farm produce is that the produce continue respiring and uses up all the oxygen within the fruit which is not being replaced as quickly as before waxing, because of the coating and produces carbon dioxide which accumulate within the fruit because it cannot escape as easily through, the coating. Eventually, the fruit will switch to anaerobic respiration that does not require oxygen. Anaerobic respiration produces more carbon dioxide, acetaldehydes and ethanol. The acetaldehyde and ethanol give off flavour to the product, which are detrimental to the perceived quality. The natural barrier of the fruit and vegetable, the type of wax and amount if it was applied will influence the extent to which the internal oxygen and carbon dioxide are modified and the level of reducing or reduction in weight loss. This method was brought about by the tendency of researchers to explore means of providing farm products to consumers in their freshness from so the use of wax was embarked upon and the result itself is formed by the use of a few ingredients which when combined with water, wetting and drying agents form the compounds used as a protective coating. Pasteur identified the growth of microorganisms such as bacteria and fungi as the scientific cause of spoilage and decay in 1860's, other cause include chemical changes from ripening and senesces (aging) process occurring in the fruit. Bacterial and fungi are everywhere in our environment and most foods provide an excellent substrate for their growth (Monso *et al.*, 2001). Vitamin C bears an obvious structural similarity with hexose sugar; hence, it is conceivable that the molecule might serve as a carbon source for respiration or bacteria growth that might be fermented (Eddy and Ingram, 1953). Storage conditions of low chemical and biological processes are also slowed down (Monso *et al.*, 2001). However, once these protective barriers are breached microbial growth is often not checked and rapidly destroys the commodity. The flavour, texture and nutrients of many fruits and vegetables are reduced before visual appearance of spoilage (Maria Gil *et al.*, 2006).

Oxygen is the most destructive ingredients in fruit juices causing degradation of vitamin C. However, one of the major sugar found in fruit juice, fructose, can also cause vitamin C breakdown. The higher the fructose the greater the loss of vitamin C conversely, the higher acid level of citric acid and malic acid stabilized vitamin C (Fadayatty, *et al.*, 2003). Consequently this study is undertaken to determine the effects of different waxing materials on stored pawpaw fruits in terms of chemical properties, minerals and antinutrients compositions with a view of establishing the suitable wax retaining substantial chemical properties and mineral composition while at the same time reducing the antinutrients composition substantially.

MATERIALS AND METHODS

Procurement and treatment of fruits: Pawpaw fruits used for this study were harvested from the same pawpaw tree in a local farm at Aagba, in Boripe Local Government Area of Osun State Nigeria. All reagents used were of food grade.

Unblemished and randomly selected pawpaw fruits were washed with potable water to remove extraneous materials and dirts.

Without drying, the fruits were divided into four groups. Three of the groups were treated with different waxes (palm kernel, honey and chemical waxes) while the fourth group served as the control sample (untreated group). Each of the three waxes was applied to the samples using cold or dipping wax method. The waxes samples were allowed to dry up and packed under the same conditions of storage with control sample for a period of four weeks. At the end of fourth week of storage, the four samples were evaluated for their chemical properties, minerals and antinutrients compositions. The four samples are coded as follows:

PKP : The group coated with palm kernel wax
HWP : The group coated with palm honey wax
CWP : The group coated with palm chemical wax
CP : The group serving as the control

Chemical analysis of pawpaw fruits: The pH of the fruits was measured using the Jenway pH meter (Model 3310). The Total Solution Solids (TSS) were determined using AOAC (1995) method. Reducing sugar and vitamin C were determined by the methods described by Pearson (1976) and AOAC (1990).

Mineral analysis of pawpaw fruits: Potassium (K) and Iron (Fe) contents of the fruits were determined using Atomic Absorption Spectrophotometer method (AOAC, 1995). Phosphorus was determined by Vanado-Molybolate methods (AOAC, 1990).

Antinutrients determinations in pawpaw fruits: Tannin, Saponin and Morphine alkaloid contents of the fruits were determined according to using the standard procedures as follows:

Tannin level was determined using the modified vanillin HCL assay method of Prince and Butler (1980).

Saponin was determined using the Folin-Denis spectrophotometric method described by Pearson (1976). Morphine alkaloid was determined using the gravimetric method of Harbvone (1973) described by Onwuka (2006).

RESULTS AND DISCUSSION

The results of chemical properties of pawpaw samples are presented in Table 1. The pH values for PKP, HWP and CWP are 5.8±0.02, 5.41±0.02 and 5.38±0.02 respectively, while that of CP is 5.91±0.02. The results indicate slight increase in the acidity of the treated and stored samples arising from anaerobic respiration of fruit. In fruits, the palate acidity or sourness depends on the hydrogen ion concentration (pH), which is affected by the degree of dissociation of the acid as wells as the acid content (Phillips, 1980). The Total Soluble Solids (TSS) for HWP, PKP and CWP, are 8.30±0.04, 7.90±0.03 and 6.63±0.03% respectively with the CP value of 9.20±0.04%. These results indicate Mild reduction in the total soluble solids of the stored fruits. There is currently a growing tendency for fruits to be classified and marketed in accordance with quality criteria, one that can be used to evaluate the quality in fruits is the total soluble content measured invasive analytical methods which are incompatible with current quality assume requirements for individual pieces of fruits (Bello *et al.*, 2008). Hence, the use of Near Infrared Reflectance (NIR) spectroscopy as a non-destructive techniques for measuring soluble solids content. The reducing sugars for HWP, PKP and CWP are 6.12±0.03, 5.60±0.02 and 5.32±0.02 g/100 g respectively and the CP is 6.40±0.03 g/100 g. Reducing sugars have reactive aldehyde or ketone group, as such, all simple sugars are reducing sugars. Although in some cases a sequence may occur in which a trend was observed for persimmon and date fruits where reducing sugars steadily increased while disaccharides decreased during ripening (Kitahara *et al.*, 1951; VanderCook and Madesgares, 1980). Vitamin C contents in HWP, PKP and CWP are respectively 26.90±0.05, 24.10±0.05 and 22.60±0.05 mg/100 g with the CP value of 27.80±0.05 mg/100 g. The results show a sharp decrease of vitamin C is an essential nutrient for humans and other animals. It protects the body against oxidative stress. It is also a cofactor in enzymatic reactions including several collagen synthesis reactions that cause the most severe symptoms of scurvy. They are important in wound healing and prevent bleeding from capillaries. It is required for a range of essential metabolic reactions in all animals and plants (Fadayatty, *et al.*, 2003).

Mineral composition values give the potassium in HWP, PKP and CWP of 196.40±0.5, 190.60±0.6 and 171.60±0.4 mg while that of CP is 198.70±0.6 mg; Phosphorus in HWP, PKP and CWP of 159.50±0.4, 157.60±0.4 and 148.70±0.3 mg with the CP value of

Table 1: Chemical properties of stored pawpaw samples

Samples	CP	PKP	HWP	CWP
pH	5.910±0.020	5.800±0.020	5.410±0.020	5.380±0.020
Total soluble solids (^{0}Brix)	9.200±0.040	7.900±0.030	8.300±0.040	6.630±0.030
Reducing sugar (g/100 g)	6.400±0.030	5.600±0.020	6.120±0.030	5.320±0.020
Vitamin C (mg/100 g)	27.800±0.050	24.100±0.050	26.900±0.050	22.600±0.050
Potassium (K) (mg)	198.700±0.600	190.600±0.600	196.400±0.500	171.600±0.400
Phosphorus (P) (mg)	161.700±0.400	157.600±0.400	159.500±0.400	148.700±0.300
Iron (Fe) (mg)	0.640±0.005	0.580±0.005	0.620±0.005	0.450±0.004
Tannin (g/100 g)	0.121±0.002	0.118±0.002	0.120±0.002	0.124±0.002
Saponin (%)	0.530±0.005	0.521±0.005	0.500±0.005	0.527±0.005
Morphine alkaloid (%)	1.540±0.006	1.460±0.005	1.530±0.005	1.400±0.005

CP = Control pawpaw sample, PKP = Pawpaw treated with palm kernel wax, HWP = Pawpaw treated with honey wax, CWP = Pawpaw treated with chemical wax

161.70±0.4 mg; Iron in HWP, PKP and CWP of 0.62±0.005, 0.58±0.005 and 0.45±0.004 mg while the CP is 0.64±0.005 mg. Potassium is a macronutrient that is extremely important as it aids and helps in the proper functioning of the cells. Phosphorus is also a macronutrient, abundantly found in nature second to calcium and required for the healthy formation of bones and teeth. It also helps to maintain health blood sugar level. It's deficiency affects the energy level in entire body, fatigue and weakness. However, excess intake can lead to osteoporosis (Sobukola and Dairo, 2007). It is made up chiefly of cellulose, hemicelluloses and pectic substances that give them their texture and firmness (Sobukola and Dairo, 2007) Iron is essential for biochemical reactions and destruction membranes (Zaich *et al.*, 2005). Iron can also be used for prevention of anaemia (Hodasi, 1986). Iron absorption can be decreased by caffeine and tannins found in coffee and tea. Iron decreases the absorption of tetracycline, but vitamin C helps the body in increasing the absorption of iron. Iron in dietary supplements exists in form of ferrous sulphate, ferrous funarate of ferrous succunate. Their major sources include unstard green, romaine (Gruff *et al.*, 1995; Hallberg, 2001). Iron also helps to maintain a healthy central nervous system but with metals like copper (Akinyele and Osibanjo, 1982).

Antinutrients compositions with respect to tannins in HWP, PKP and CWP are 0.120±0.002, 0.118±0.002 and 0.124±0.002 g/100 g respectively against the CP value of 0.121±0.002 g/100 g; Saponm values in HWP, PKP and CWP values of 0.500±0.005, 0.521±0.05 and 0.527±0.005 compared with CP value of 0.530±0.005%; Morphine alkaloid in HWP, PKP and CWP are respectively 1.53±0.005, 1.460±0.005 and 1.400±0.005% while the CP has a value of 1.540±0.006. Tannin is a polyphonic compound that either bunds and precipitates or shrunk proteins and various other organic compounds including amino acids and alkaloids. The astringency from the tannins is what causes the dry and prickery feeling in the month following the consumption of unripped fruit or red wine. Likewise the destruction or modification of tannins with time plays an important role in ripening of fruit and aging wine. The term tannin by extension is widely applied to any large polyphenolic compound containing sufficient hydroxyls and other suitable group (such as carboxyls) to form strong complexes with proteins and other macromolecules. Botanically tannins are mainly physically located in the vacuoles or surface wax of plant. This storage sites keep tannins active against plant predators, it is only after the breakdown of cell and death that tannins are active in metabolic effects. They are classified as ergastic substance, i.e. non-protoplasm materials found in cells (Muller-Harvey and Mc Allan, 1992; Bate-Smith and Swain, 1962).

In plant, saponins may serve as antifeedants and to protect the plant against microbes and fungi (Liener Irvin, 1980). Some plant saponins may enhance nutrient absorption and aid in animal digestion, however, saponins are often biter to taste and so can reduce plant palatability or even imbue them with life threatening animal toxicity. Researches have shown that saponins are toxic to cold-blooded organisms and insect at particular concentration. Most saponins which readily dissolve in water are poisonous to fish (Francis George, *et al.*, 2002).

Alkaloids are a group of naturally occurring chemical compound which mostly contain basic nitrogen atoms, this group also includes some related compounds with neutral and even weakly acidic properties. Most alkaloids have bitter flavour, it is behaved that plants evolved the ability to produce these bitter substances, many of which are poisonous, in order to protect themselves from the animals; however, animals in turn evolved the ability to detoxify alkaloids. Some alkaloids can produce developmental defects in the offspring of animals that consume them but cannot detoxify them. But alkaloid has long being used in the medical world in form of drug production. Many synthetic and semi synthetic drugs are structural modifications of the alkaloids which were designed to enhance or change the primary effect of the drug and reduce unwanted side effects. Some alkaloids such as salts of nicotine and anabasine were been used as insecticides, their use was limited by their use was limited by their high toxicity to humans. Pure alkaloids have long been used as psychoactive substances like cocaine and cathinone are stimulants of the central nervous system.

Conclusion: Application of palm kernel, honey and chemical waxes on pawpaw and subsequently storage for a period of four weeks brought about mild decrease in the chemical properties (pH, Total soluble solids, Reducing sugar and Vitamin C) contents); mineral compositions (Potassium, Phosphorus and Iron) and Morphine alkaloid).

Pawpaw sample treated with honey wax retained the highest chemical properties (total soluble solids, reducing sugar and vitamin C) while the pH is best retained by the treatment with palm kernel wax. Similarly the sample treated with honey wax retained the least with chemical wax retained the least value of morphine alkaloid while the sample treated with palm kernel wax retained the least value of tannin.

Therefore, for maximum retention of chemical properties and mineral compositions as well as least retention of antinutrients, honey wax coating of pawpaw fruits is found to be generally suitable to apply before storage.

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