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Effect on Three Different Waxes on Some Chemical Properties, Minerals and Anti Nutrients Compositions of Banana (*Musa sapentum*)

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Abstract: The effects of using three different waxing materials (palm kernel, honey and chemical waxes) on some chemical properties, minerals and antinutrients compositions of banana fruits stored for a period of four weeks were studied. Banana fruits used for the study were obtained from a local farm at Aagba, in Boripe Local Government area of Osun State, Nigeria. The harvested fruits were grouped into four. Three of these were differently treated with the waxing materials using the cold or dipping wax method while the fourth group was not treated (control sample). The four samples were then stored under the same conditions of storage for four weeks. They were thereafter evaluated for their chemical properties, minerals and antinutrients compositions using the recommended standard methods. The results of chemical analysis are the pH range 6.40±0.03 - 6.80±0.03, Reducing sugar 14.20±0.04 - 17.60±0.05, Total soluble solids 12.38±0.03 - 14.60±0.04 and vitamin C 16.70±0.04 - 21.40±0.050. The mineral analysis results are potassium 285.40±0.5 - 301.7±0.6, Phosphorus 270.10±0.6 - 288.30±0.6 and Iron 1.24±0.05 - 1.48±0.05. The antinutrients composition results are tannin 0.136±0.005 - 0.148±0.004, Saponin 0.710±0.005 - 0.753±0.005 and Morphine alkaloid 1.427±0.005 - 1.450±0.006. Palm kernel, honey and chemical waxes mildly decrease the chemical properties, minerals and antinutrients compositions of the banana fruits treated by them and stored. Banana sample treated with honey wax preserved the fruits better than others in terms of antinutrients compositions. However, reduction of Morphine alkaloid in the banana fruits is better achieved using chemical wax rather than honey or palm kernel waxes.

Key words: Waxes, antinutrients, banana, chemical properties

INTRODUCTION

Some Scientists like Louis Pasteur (French chemist and Microbiologist) Clarence Birds eye (American Businessman and inventor) and Nicolas Appert (French Chief) are generally ascribed with preservation and their various research works led to the various ways of preserving food crops or materials which have been diversified into the different ways of preservation.

The life of many foods may be increased by storage at temperature below 4°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 retard spoilage. Commonly refrigerated foods include fresh fruits and vegetables, eggs, dairy products and meats. Tropical fruits like banana 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 dehydration causes loss of nutrients during processing, the need for an effective way of extending the shelf life of fruits propelled the scientists to venture 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 packaging materials. Many fruits develop a waxy coat on their epidermis as they mature on the plant (apples bananas, mangoes and grapes) which can either be felt or seen as a powdery cont and usually develops when the fruit has attained two- third of its growth. 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 involve restricting the rate of respiration and preventing moisture loss, so as to maintain the vital food elements in as near the same quality as in the freshly picked fruit or vegetable.

Shelf life is most influenced by several factors: exposure to light and heat, transmission of gases (including humidity), mechanical stresses and contamination by microorganisms. Product quality is often mathematically modeled around a parameter (concentration of a chemical compound, microbiological index or moisture content) (Kilcast and Subramaniam, 2000). For some foods the shelf life is an important factor. Contaminations by microorganisms are ubiquitous and foods left unused for too long will often acquire substantial amount of bacterial colonies and become dangerous to eat, leading to food poisoning. However,

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the shelf life is not an accurate indicator to the food safety, for example, pasteurized milk can remain fresh for five days after sell - by date, if it is refrigerated properly. In contrast, if the milk already has harmful bacteria, the use by dates becomes irrelevant (Gyesley, 1991).

Most tropical fruits are seasonal and highly perishable. They include oranges, pineapples, mangoes, pawpaw (papaya), cashew fruits 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 imposes physiological stress and accelerates a biochemical reaction that speeds up deterioration in reaction that speeds up deterioration in the fruits. Tropical fruits which have nutritional and medicinal values are very seasonal and deteriorate speedily shortly after harvest. This situation needs to be prevented using suitable storage techniques, packaging material that is appropriate to each fruit produced, 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 see how suitable they could be adopted in developing countries to store tropical fruits in order to reduce their wastage. Findings have shown that there is scarcity of technologically suitable and economy 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.

Efforts are therefore being intensified to improve on the methods available for extending both the shelf and the storage life of fruits through refrigeration regulation and modification of the storage atmosphere (CAS), packaging in plastic films and use of food surface coatings e.g. wax, chemical treatment and irradiation. It is obvious from the reasons aforementioned that besides packaging 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 more stable secondary products like jams and jellies.

The principle involved during the storage of farm products is that the produce continues 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, acetaldehyde 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 applied will influence the extent to which the internal oxygen and carbon dioxide are modified and the level of 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, so the use of wax was ventured into and the result has been quite encouraging. Wax 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 1860s, other causes include chemical changes from ripening and senescence (aging) process occurring in the fruit. Bacteria and fungi are everywhere in our environment and most foods provide excellent substrate for their growth (Mouso *et al*., 2001). Vitamin C bears an obvious structural similarity with hexose sugar, hence. It is conceivable that the molecule might serve as a carton 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 (Mouso *et al*., 2001). However, once these protective barriers are breached, microbial growth is often unchecked and rapidly destroys the commodity. The flavor, texture and nutrition of many fruits and vegetables are reduced before visual appearance of spoilage (Maria Gil *et al*., 2006).

Oxygen is the most destructive ingredients in juice causing degradation of Vitamin C. However, one of the major sugar found in organ juice, fructose, can also cause Vitamin C breakdown. The higher the fructose, conversely, the higher the acid level of citric acid and malic acid stabilized Vitamin C (Padayatti *et al*., 2003). Consequently this study is undertaken to determine the effects of palm kernel, honey and chemical waxes on some chemical properties, minerals and anti nutrients compositions of banana samples treated separately by them and stored for four weeks with a view of establishing the appropriate waxing material; that would enhance maximum retention of chemical properties and minerals and at the same time reduced the anti nutrients to the bearest minimum.

MATERIALS AND METHODS

Procurement and treatments of fruits: Banana fruits used for the study were obtained from the same bunch harvested from a local farm at Aagba, in Boripe Local Government area of Osun State, Nigeria. Unblemished and randomly selected banana fruits were thoroughly washed under tap water to remove extraneous materials and dirt's. Without drying the banana fruits were divided into four different groups. Three of the groups were differently treated with palm kernel, honey and chemical waxes while the fourth group was not treated with any of the waxes but served as a control sample. The three waxes were respectively applied to the samples using cold or dipping wax method. The treated samples were allowed to dry up and packed under the same conditions of storage with untreated sample for a period of four weeks. At the end of fourth week of storage the four samples were respectively evaluated for their chemical properties, minerals and anti nutrients compositions. The four samples are coded as follows:

PKB : Banana treated with palm kernel wax
HWB : Banana treated with honey wax
CWB : Banana treated with chemical
CB : Untreated banana sample

Chemical analysis of banana fruits: The P^H was measured using the Jen way pH meter (model 3310). The total soluble 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 banana fruits: Potassium (K) and Iron (Fe) contents of the banana samples were determined using Atomic Absorption spectrophotometer (AOAC, 1995). Phosphorus was determined by Vando-molybdate methods (AOAC, 1990).

Anti nutrients determination in banana fruits: Tannin, Saponin and Morphine alkaloid contents were determined according to using the standard procedures as follow:
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 gravimetric method of Harbone (1973) describe by Onwuka (2006).

RESULTS AND DISCUSSION

The results of chemical properties, minerals and antinutrients compositions of the banana fruit samples are presented in Table 1. The pH for PKB, HWB and CWB are 6.65±0.03, 6.60±0.03 and 6.40±0.03 respectively while the pH for CB is 6.80±0.30. The results indicate slight increase in the acidity of the stored banana fruits samples. In fruits the perceived acidity or sourness depends on the hydrogen ion concentration (pH), which is affected by the degree of dissociation of the acid as well as the acid content (Phillips, 1980) The total soluble solids for PKB, HWB and CWB are 13.70±0.03, 12.90±0.03 and 12.38±0.03% respectively while that of CB is 14.60±0.04%. These results indicate mild reduction in the total soluble solids of the stored banana samples. 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 contents, measured by invasive analytical methods which are incompatible with current quality assurance requirements for individual fruits. The use of near Infrared Reflectance (NIR) spectroscopy as a non-destructive technique for measuring soluble solid content (Bello *et al.*, 2008). The reducing sugars for HWB, PKB and CWB are 16.90±0.030, 16.40±0.03 and 14.20±0.04 g/100 g respectively; CB has reducing sugar of 17.60±0.05 g/100 g. Reducing sugars have reactive aldehyde or Ketone group, as such, all simple sugars are reducing sugars. A reducing sugar has an open chain with an aldehyde or ketone group. 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 disaccharide decreased during ripening (Kitahara *et al.*, 1951; Vandercook and Madegaves, 1980).
Vitamin C contents in PKB, HWB and CWB are respectively 20.70±0.05, 18.40±0.04 and 16.70±0.04 mg/100 g while that of CB is 21.40±0.05 mg/100 g. These results show a sharp decrease in the content of the stored banana fruit samples. Vitamin C is an essential nutrient for humans and other animal species. 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 (Padayatti *et al.*, 2003).
For the mineral compositions, HWB, PKB and CWB have potassium contents of 301.10±0.5, 300.40±0.5 and 285.40±0.5 mg/100 g respectively while the CB has a value of 301.70±0.6 mg/100 g; phosphorus contents of 273.60±0.4, 270.10±0.6 and 288.30±0.6 mg/100 g respectively and the CB 275.4±0.5 mg/100 g; Iron contents of 1.41±0.06, 1.35±0.05 and 1.24±0.05 mg/100 g respectively while the CB has a value of 1.48±0.05 mg/100 g. 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 healthy blood sugar level. Its deficiency affects the energy level in the body, fatigue and general weakness. However, excess intake can lead to osteoporosis (Sobukola and Dairo, 2007). It is made up chiefly of Cellulose, hemicellulose and pectic substances that give them their texture and firmness (Sobukola and Dairo, 2007). Iron is essential for biochemical reactions and destruction of membranes (Zaidi *et al.*, 2005). Copper toxicity in fruits

Table 1: Chemical properties, minerals and antinutrients compositions of stored banana samples

Samples	CB	PKB	HWB	CWB
pH	6.800±0.030	6.650±0.030	6.600±0.030	6.400±0.030
Total soluble solids (%)	14.600±0.040	13.700±0.030	12.900±0.030	12.380±0.030
Reducing sugar (g/100 g)	17.600±0.050	16.900±0.030	16.400±0.030	14.200±0.040
Vitamin C (m/100 g)	21.400±0.050	20.700±0.050	18.400±0.040	16.700±0.040
Potassium (K) (mg)	301.700±0.600	301.100±0.500	300.400±0.500	285.400±0.500
Phosphorus (P) (mg)	275.400±0.500	273.600±0.400	270.100±0.600	288.300±0.600
Iron (Fe) (mg)	1.480±0.050	1.410±0.060	1.350±0.050	1.240±0.050
Tannin (g/100 g)	0.148±0.004	0.144±0.004	0.140±0.004	0.136±0.005
Saponin (%)	0.740±0.005	0.753±0.005	0.724±0.005	0.710±0.005
Morphine alkaloid (%)	1.450±0.006	1.447±0.006	1.442±0.005	1.427±0.005

CB: Control banana sample, PKB: Banana treated with palm kernel wax, HWB: Banana treated with honey wax, CWB: Banana treated with chemical wax

induces iron deficiency, lipid peroxidation and destruction of membranes (Zaidi *et al*., 2005). Iron can also be used for prevention of anaemia (Hodasi, 1986). Iron decreases the absorption of tetracycline, but Vitamin C helps the body in increasing the absorption of iron. 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 PKB, CWB and HWB are 0.144±0.004, 0.140±0.004 and 0.136±0.005 g/100 g while that, of CB is 0.148±0.004 g/100 g; Saponin in CWB, PKB and HWB are 0.753±0.005, 0.724±0.005 and 0.710±0.005% respectively while the CB's valve is 0.740±0.005%; morphine alkaloid in HWB, PKB and CWB are 1.442±0.005, 1.447±0.006 and 1.427±0.005% respectively while that of CB is 1.450±0.006%. Tannin is a polyphonic compound that either binds and precipitates or shrinks proteins and various other organic compounds like amino acids and alkaloids. The astringency from the tannins is what causes the dry and prickery feeling in the mouth following the consumption of unripened fruit. 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 break down of cell and death that tannins are active in metabolic effects. They are therefore classified as ergastic substance, i.e. non-protoplasm materials found in the cells (Muller-Harvey and Mc Allah, 1992; Bate-Smith and Swain, 1962).

In plants, saponins may serve as anti-feedants and to protect the plant against microbes and fungi (Liener Irvin, 1980). Some plant saponins may enhance nutrient absorption and animal digestion, however saponins are often bitter to taste and so can reduce plant palatability. Researchers have shown that saponins are toxic to cold blooded organism and insect at particular concentration, most saponins which are readily dissolve in water are poisonous to fish (Francis *et al*., 2002).

Alkaloids are a group of naturally occurring chemical compounds 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 believed that pants have the ability to produce these bitter substances. Many of them are poisonous, in order to protect themselves from the animals, however, animals also have 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 uses was limited by their high toxicity to humans. Pure alkaloids have long been used as psychoactive substances like cocaine and cathinone which are stimulants of the central nervous system.

Banana fruits sample coated with honey wax has chemical properties and mineral compositions that are relatively closer to those of untreated sample. This same sample also has the lowest values of tannin and saponin contents while the sample coated with chemical wax has the least value of morphine alkaloid content.

Conclusion: Banana fruits coated with palm kernel, honey and chemical waxes and stored for four weeks have their chemical properties, minerals and antinutrients compositions mildly reduced relative to the untreated banana fruits. The sample treated with honey wax relatively retained chemical properties and minerals substantially while two of the antinutrients were also reduced substantially in this sample. However, chemical wax was found to reduce the morphine alkaloid in banana fruits better than the other two waxes.

Therefore, to achieve maximum retention of chemical properties and mineral compositions as well as least retention of antinutrients, honey wax is generally found to be relatively suitable for banana fruits.

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