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Effect of Biological and Chemical Ripening Agents on the Nutritional and Metal Composition of Banana (Musa spp)

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ABSTRACT: The use of potentially toxic ripening agents is common in developing countries. Four ripening agents namely calcium carbide, potash, African mango and *jathropha curcas* leaf were used and compared with a control with no ripening agent. Result showed that RB1 and RB2 were the first to ripen at 3days with RB5 at 6th day. Protein content reduced in the ripened samples in the order of 4.12>3.68>3.04>2.52>1.99>1.77%. Protein value was lowest when calcium carbide was used. Fat ash and fiber contents range between 0.28-1.72, 0.75-2.75and 0.50-1.75% respectively. The moisture content increased from 65.50 to 74.0%, while carbohydrate content range is 17.49-29.29%. Pb, Cu, Zn and Mn values of 0.22, 0.87, 1.96 and 0.67ppm was highest in calcium carbide ripened banana and lowest in the control 0.09, 0.26, 0.37 and 0.19 ppm. © JASEM

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Ripening is a biochemical process which involves a series of physiological changes in colour, aroma, flavor and texture. Banana is a climateric fruit showing an increase in respiration resulting in colour, flavor, aroma and texture changes. It is usually eaten raw when ripe and is a major starchy food common in Sub-Sahara Africa and Asia, providing more than 25% of carbohydrate (Adeniji et al, 2007). The consumption of banana cuts across every age group, from little children to adults, and it supplies necessary calories and essential micronutrients. Once harvested it is highly perishable, with short shelf life leading to high post harvest losses of about 20-50% due to poor handling and quality deterioration (Ajayi and Mbah, 2007; Zewter et al, 2012). In order to reduce the high post harvest losses, bananas are harvested when green but mature, and artificially ripened when needed with the use of ripening agents. Ripening agents are substances which hasten the ripening process, and it comes in different forms. These include ethylene gas, ethephon, ethylene glycol, etherel and calcium carbide (Singal et al, 2012); African bush mango fruit (*irvingia gabonesis*) and leaves, Palm nut, Cassia leaves, Yellow Pawpaw leaves, torch light battery, calcium carbide, potash and ash (Ajayi and Mbah, 2007). African mango fruits, calcium carbide and newbouldia leaves were also reported by Adewole and Duruji (2010). According to Singal et al (2012), the commercial practice is to use these ripening agents to artificially ripen the fruits at the destination market before retailing. Ethylene gas is expensive to produce so low cost indigenous ripening technologies involving the use of hazardous materials are used (Singal et al 2012; Ajayi and Mbah, 2007). The adverse potential of calcium carbide as a ripening agent has been established (Singal et al, 2012) while other chemical ripening agents like ethepon, etherel and ethylene glycol are also considered hazardous to health and they have to be used within recommended safe limits (Hakim et al 2012; Food and Beverage Online, 2010). The use of toxic and suspicious ripening agents is of great concern as the activities of human beings have been said to contribute to exposure of food materials to heavy metal contamination (Orisakwe et al, 2012). The use of artificial agents may give more acceptable colour than naturally ripened fruits (Hakim et al, 2012) but it may increase the risk of contamination of food materials. With the absence of legislation to control the indiscriminate use of harmful ripening agents, research effort is needed to constantly monitor their presence in foods grown locally. This present study is therefore carried out to compare the use of biological and chemical ripening agents on the nutritional composition of bananas.

MATERIALS AND METHODS

Freshly harvested bunch of green but mature unripe banana was bought from the local market in Offa, Nigeria on the market day when fresh produce is brought to the market for sale. The ripening agents used for the study were also bought from the same market and these are calcium carbide, potash, African

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bush mango fruit (*irvingia gabonesis*) and *jathropha curcas* leaves. The banana bunch was cut and separated into 5groups made up six (6) banana fingers of approximately the same size each. The calcium carbide and potash were wrapped in polythene before being dropped into a black polythene bag containing the bananas. African mango and the jathropha leaves were washed in cold water and also placed in polythene bags containing banana, while the last batch was placed in the polythene bag without any ripening agent and used as the control sample. All the bags were tied up and stored in the same room. All the samples were daily monitored for colour changes of the peel indicative of ripening. The stage of ripeness is judged primarily by colour using a 1-7 scale common in the industry. At colour 1, the finger is hard and completely green; No 2 is green but with some traces of yellow; No 3 more green than yellow; No 4 more yellow than green; No5 yellow but with traces of green; No 6 fully yellow and No 7 is yellow with black spots (Foster et al, 2003). Each treatment was carried out in duplicate. The physiochemical properties of the unripe and ripe bananas were determined according to standard methods of AOAC, (1990). Mineral and heavy metal contents of the samples were determined using atomic absorption spectrophotometer AAS.

RESULT AND DISCUSSION

The period of ripening is usually determined by the change in colour of the banana peel. The fastest colour change indicated by the peel colour to full yellow was observed in RB1 and RB2 on day 3 while the untreated banana with no ripening agent ripened last on day 6. This result agrees with most research work in literature that ripening agents do accelerate ripening faster than when done naturally (Adewole and Duruji, 2010; Hakim et al, 2012 and Singal et al, 2012). Calcium carbide can induce ripening within 24hrs and the fact that it is cheap makes it to be a popular ripening agent among banana marketers especially in the developing countries (Ajayi and Mbah, 2007)

Table 1- Physiochemical properties of unripe and ripe banana

		Chemical		Biological		Control
Property %	UB	RB1	RB2	RB3	RB4	RB5
Crude protein	4.12	1.77	1.99	2.52	3.04	3.68
Fat	0.70	1.25	0.75	0.28	1.72	1.00
Crude fiber	1.27	0.75	0.67	0.50	1.75	0.62
Ash	1.25	2.75	1.50	1.00	2.00	0.75
Moisture	65.5	70.25	67.25	66.50	74.0	69.0
Carbohydrate	27.16	23.23	27.89	29.29	17.49	24.57

UB-unripe banana, RB1 is banana ripened with calcium carbide, RB2 is banana ripened with potash, RB3 is banana ripened with African mango fruit, RB4 is banana ripened with *jatropha curcas* leaf, RB5 is banana ripened without any ripening agent.

Table 1 shows the mean of the result of the properties of unripe and ripe bananas. The protein content of the unripe banana was 4.12%. This reduced during ripening to 3.68% in naturally ripened banana (RB5) and reduced to less than 50% of its value in calcium carbide ripe bananas RB1 (1.77%). The biological agents had higher protein contents 2.52% and 3.04% for RP3and RP4, than the chemically ripened with protein values of 1.77% and 1.99% for RP1 and RP2. This is also in agreement with Adewole and Duruji (2010) who observed a reduction in the protein content during ripening which may be due to reduction of nitrogen during ripening. However it does not agree with Sen et al (2012) who stated that proteins increases during ripening. The differences in the protein values during ripening of bananas may be due to varietal differences (Mohapatra et al, 2010). As a fruit banana is eaten raw and also made into purees used in the production of baby formulas, so every effort should be made to check a reduction in protein value. However the protein values were still within those reported in Nigeria 1.88-6.8% (Ayo-Omogie et al, 2011). Fat content ranged between 0.28- 1.72%. Fat content increased in unripe banana 0.7(UB) to 1.72% (RB4) with the lowest in RB3. The fat and fiber content for RB4 were the highest at 1.72 and1.75% and lowest in RB3after ripening. Ash content ranged between 1.0-2.75% which was highest in RB1, but there was no particular trend during ripening as some increased and some reduced. The moisture content of the ripe bananas ranged between 66.5-74.0%. It increased from 65.5% in UB to 74% in RP4. Moisture content values of 74.91%, 73.8% and 68-70.45% in ripe bananas have been reported (Hakim et al, 2012; Mohapatra et al, 2010 and Sen et al, 2012). Moisture content in banana pulp is observed to increase because of respiratory breakdown of starch to sugar, migration of water from peel to pulp and excess moisture formation (Sen et al, 2012; Ayo-Omogie, 2010; Hakim et al, 2012). The high moisture content of banana contributes to its short storage life and high post harvest loss. There was reduction in carbohydrate content of the bananas during ripening from 27.16% to 17.49%, except for RB2 and RB3. According to Sen et al, (2011) one of the biochemical changes occurring during ripening is a decrease in carbohydrate content. The starch is degraded by starch degrading enzymes α and β amylases which convert starch to simple sugars (Ayo-Omogie et al, 2010).

Table 2- Heavy metal and mineral element of banana ripened with and without ripening agents

	RB1	RB2	RB3	RB4	RB5
Pb(ppm)	0.22	0.18	0.10	0.16	0.09
Cu(ppm)	0.87	0.29	0.28	0.26	0.26
Zn(ppm)	1.96	0.22	0.64	0.39	0.37
Mn(ppm)	0.67	0.48	0.33	0.21	0.19

RB1-calcium carbide ripened banana, RB2-potash ripened banana; RB3-African mango; RB4- *jatropha curcas* ripened banana, RB5- banana with no ripening agent

Table 2 presents the heavy metal and mineral elements of unripe and ripe bananas. Minerals whether macro or micro-minerals are required in the body for the maintenance of physiochemical processes essential to life. While minerals like K,Mg, Ca, Zn, Fe Cu, are considered essential, heavy metals like Pb, Cd and Sn are considered as a toxic contaminant and evidence of their requirements and essentialness for the body is weak (Soetan et al, 2010; Sobukola et al, 2009).The naturally ripened bananas with no ripening agent (RB5) had the lowest Pb value- 0.09ppm, while carbide (RB1) and potash (RB2) had the highest values of 0.22 and 0.18ppm. The Pb content in RB1 and RB2 is double the value in RB5 with zero ripening agent. The values for the biological agents remained almost the same when compared with RB5. Though the Pb values increased when carbide and potash were used, the range of Pb in the samples is 0.09-0.22ppm which is comparable with Pb value in banana of 0.118ppm as reported by Sobukola et al (2010), and lower than the maximum permissible limits of 0.3ppm for foods (Orisakwe, 2012). Presence of Pb in fruit may be from the soil as high levels of Pb was reported in different farmlands in Eastern Nigeria (Orisakwe, 2012) and in fruits like banana, apple and pineapple in Lagos, Nigeria (Sobukola et al, 2010).The presence of Pb detected in the ripened bananas could also be due the type of storage/packaging material used during ripening. Banadda et al (2011) reported the migration of Pb from black polythene bag into cooked green banana. They reported that Pb and Cd which are residues from the polymerization process of polythene can migrate at high temperature and under long storage period. Since chemical ripening agents like carbide are used to generate heat, the high temperature needed for the heavy metals to migrate is provided (Ajayi and Mbah, 2007). The degree of toxicity of heavy metals to the body depends on the daily intake and since these metals are non-biodegradable there is concern if it continues to be taken by the body over time. Micro-mineral deficiency is of great concern in developing countries especially among little children. Minerals are involved in the metabolic activities during ripening in the form of micro and macro mineral. All the mineral elements Cu, Zn and Mn increased in value with RB1 having the highest values for Cu, Zn and Mn 0.87, 1.96 and 0.67ppm respectively. Cu has a range of 0.26-0.87, Zn 0.22-1.96 and Mn 0.19-0.67ppm in all the ripened bananas. The acceptable limit of Cu for humans is 10ppm, while fruits and vegetables are poor source of Zn, and the recommended range for Mn is 0.42-6.64ppm (Ismail et al, 2011). All the values are within the recommended limits and all comparable with those in literature.

Conclusion This study has determined the effect of artificial ripening agents on properties of banana. It has confirmed other research work that artificial ripening accelerates ripening, but affects the nutritional quality of the fruits. The use of storage materials apart from polythene films and ripening agents of biological nature can be encouraged for use as they are available in various forms, abundant and cheap with reduced risk of contamination.

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