African Journal of Food Science Vol. 5(10), pp. 589-593, 30 September, 2011
Available online http://www.academicjournals.org/AJFS
ISSN 1996-0794 ©2011 Academic Journals

Full Length Research Paper

Investigating the effect of cooking on color and texture of green bananas (*Matooke*) wrapped in polyethylene bags

Namawejje, H., Banadda, N*, Kigozi, J. B., Ayaa, F. and Sendagi, S.

Department of Agricultural and BioSystems Engineering, Makerere University, P. O. Box 7062, Kampala, Uganda.

Accepted 9 September, 2011

Traditionally, green bananas locally known as *Matooke* are wrapped in banana leaves during steaming for the purposes of keeping it warm. However, due to factors such as changing life styles, the spread banana wilt disease, and the emergence of synthetic materials, banana leaves are no longer the number one choice as a wrapping material during cooking. Increasingly, food vendors and cooks are turning to the use of polyethylene (PE) bags as a replacement for banana leaves. This study investigated the effect of cooking on colorimetric and texture changes of green bananas (*Matooke*) with and without wrapping in polyethylene bags. Color and texture changes were measured at cooking times of 1, 2 and 3 h under three holding temperatures of 65, 90 and 100°C. In general, results showed color degradation was highest at 100°C and 3 h of cooking with PE bags. The study makes two conclusions. First, texture measurements (penetration) were better for *Matooke* wrapped in PE bags than without PE bags at 100°C and 3 h. Secondly, yellow was the most dominant color for the two case studies of with and without wrapping in PE bags.

Key words: *Matooke*, polyethylene bags, temperature, color degradation, texture.

INTRODUCTION

Matooke (green bananas) is the staple food of most people in Uganda. They are eaten deep fried, baked, or steamed when wrapped in banana leaves. Banana is the common name for herbaceous plants of the genus *Musa.* Traditionally*, Matooke* are wrapped in banana leaves during steaming for the purposes of keeping it hot/warm. But, as mentioned by Kigozi et al. (2010), other materials, such as black polyethylene bags are slowly replacing banana leaves during cooking. Increase in the use of polythene bags in this role is due to their high thermal seal ability and barrier properties to water (Kanetkar et al., 2007). *Matooke* is placed in polythene bags immediately after peeling in which it is well wrapped before cooking. It is then cooked until it is ready and upon readiness, it is pressed (mashed) and cooked further for purposes of softening and keeping it warm for later consumption.

Commercial food vendors are sure to serve a hot meal without necessarily spending a lot on energy (Banadda et al., 2011). For this study, two organoleptic properties, that is, color and texture changes, were studied. According to Nicoletta et al. (2010), different cooking methods have different effects on color changes of the food and the firmness of banana pulp tissues decrease rapidly with increase in temperature and duration of cooking (Baoxiu et al., 2000). With the longer periods of cooking *Matooke*, which is the common practice in most parts of central Uganda, it is perceived that the color and texture improve. In this study, the effect of cooking on colorimetric and texture changes of green bananas (*Matooke*) with and without wrapping in polyethylene bags is investigated.

MATERIALS AND METHODS

Color measurements

A solution of 0.1 M sodium hydroxide was prepared by dissolving

*Corresponding author. E-mail: banadda@agric.mak.ac.ug. Fax: +256-41-531641.

Table 1. Color measured at cooking temperature of 65°C.

Sample code	Color reading			Color value difference			Name of color
	Red	Yellow	Blue	Red	Yellow	Blue	Yellow/ Orange
T = 65°C, 1 h							
without PE	1.0	2.6	0.1	0.9	2.5	0	+1.6 yellow
with PE	0.8	2.2	0	0	1.4	0	+1.4 yellow
T = 65°C, 2 h							
without PE	1.0	3.2	0.6	0.4	2.6	0	+2.2 yellow
with PE	0.8	2.9	0	0	2.1	0	+2.1 yellow
T = 65°C, 3 h							
without PE	1.1	3.9	0.5	0.6	3.4	0	+2.8 yellow
with PE	1.0	3.2	0.1	0.9	3.1	0	+2.2 yellow

sodium hydroxide pellets in water. This solution was used together with 95% ethanol to sterilize all the equipment and apparatus used for this study. De-mineralized water was used to prepare all solutions. Green banana fingers (*Matooke*) used in this study were randomly collected from Kasubi market in Kampala, Uganda. Ten *Matooke* fingers were wrapped in two black polyethylene bags (Plasto-Foam brand, medium size 22” gauge of 30 µm thickness commonly used for wrapping foodstuffs in local markets) to prevent heat loss as it is done in the field conditions.

Nine sample tests were prepared (each with ten *Matooke* fingers), and placed in three well-stirred thermo-stated water bath (Grant instruments, Cambridge England), each pre-set at temperatures of 65, 90 and 100°C. For a given water bath, three sample tests and three pieces of *Matooke* not wrapped in a polyethylene bag were placed in at the same time. Sampling was done at intervals of 15 min for the different water baths to ensure correct timing. After 1 h of cooking, sample tests were taken out from the respective water bath, pressed gently and samples drawn. Sampling was carried out using a manual stainless steel device, 3 cm internal diameter, 9 cm long with a square metallic handle to allow easier sampling of hot *Matooke*. A piece of *Matooke* unwrapped in a polyethylene bag was taken out of the water bath and was placed on an aluminum foil. The sample tests were returned to the water baths and cooking continued for another hour. After the second hour of cooking, the sample tests were removed from the water bath and a second sample was obtained from each sample test. The second piece of *Matooke* unwrapped in a polyethylene bag was taken out of the water bath and was placed on an aluminum foil. The sample tests were returned to the water baths and cooking continued for another hour. After the third hour of cooking, the sample tests were removed from the water bath and a third sample was obtained from each sample test. The third piece of *Matooke* unwrapped in a polyethylene bag was taken out of the water bath. The samples were allowed to first cool before carrying out color measurements. The tintometer (Lovibond Model E) was used to measure the color of the samples. A sample was placed in position so that it could be seen in the left hand field of the viewing tube. The triangular knobs (which control the colored filters) were slid towards the right, adjusting the red, yellow and blue in correct proportion until a perfect color match was obtained. The values of the slides were recorded.

Texture measurements

The penetrometer (Wagtech international, model B057-10) was used to determine the amount of penetration into the samples. The penetration cone was inserted into the chuck and the chuck screw was tightened. Weights of 200 g were added to the plunger head to make up the required load for the test. The prepared sample was placed in position on the base. The height of the mechanism head was adjusted via the control sleeve on the main post so as to bring the point of the penetration cone exactly into contact with the surface of the sample. The test plunger was released, allowing the penetration cone to descend into the sample during the specified time required for the test. The depth of penetration was read off the dial gauge.

RESULTS AND DISCUSSION

Color measurements

Red, yellow and blue colors were the measured colors. Table 1 summarizes the color readings at 65°C after 1, 2 and 3 h of cooking. From Table 1, the yellow color measured for the *Matooke* cooked without polyethylene bags was greater than that measured for the *Matooke* wrapped in polyethylene bags thus there was color degradation of the *Matooke* when it was wrapped in polyethylene bags. The yellow color increased with increase in cooking time. Table 2 summarizes the color readings at 90°C after 1, 2 and 3 h of cooking.

From Table 2, the yellow color measured for the *Matooke* cooked without polyethylene bags was greater than that measured for the *Matooke* wrapped in polyethylene bags thus there was color degradation of the *Matooke* when it was wrapped in polyethylene bags. The yellow color increased with increase in cooking time and was greater than that measured for each cooking time at 65°C. Table 3 summarizes the color readings at 100°C after 1, 2 and 3 h of cooking. From Table 3, the yellow color measured for the *Matooke* cooked without polyethylene bags was greater than that measured for the *Matooke* wrapped in polyethylene bags thus there was color degradation of the *Matooke* when it was wrapped in polyethylene bags. The yellow color

Table 2. Color measured at cooking temperature of 90℃.

Sample code	Color reading			Color value difference			Name of color
	Red	Yellow	Blue	Red	Yellow	Blue	Yellow/ Orange
T = 90℃, 1 h							
without PE	1.3	3.5	0.4	0.9	3.1	0	+2.2 yellow
with PE	1.0	2.9	0	0	1.9	0	+1.9 yellow
T = 90℃, 2 h							
without PE	1.2	4.2	1.0	0.2	3.2	0	+3.0 yellow
with PE	1.4	4.1	0	0	2.7	0	+2.7 yellow
T = 90℃, 3 h							
without PE	1.2	5.2	0.2	1.0	5.0	0	+4.0 yellow
with PE	1.1	3.4	0.1	1.0	3.3	0	+2.3 yellow

Table 3. Color measured at cooking temperature of 100℃.

Sample code	Color reading			Color value difference			Name of color
	Red	Yellow	Blue	Red	Yellow	Blue	Yellow/ Orange
T = 100℃, 1 h							
without PE	1.5	5.7	0.3	1.2	5.4	0	+4.2 yellow
With PE	1.1	3.2	0.1	1.0	3.1	0	+2.1 yellow
T = 100℃, 2 h							
without PE	1.2	6.4	0.4	0.8	6.0	0	+5.2 yellow
with PE	1.2	4.9	0.5	0.7	4.4	0	+3.7 yellow
T = 100℃, 3 h							
without PE	1.6	7.4	1.6	0	5.8	0	+5.8 yellow
with PE	1.6	6.6	0.6	1.0	6.0	0	+5.0 yellow

increased with increase in cooking time and was greater than that measured for each cooking time at 65 and 90℃

Texture measurements

The measured depth of penetration was converted from degrees to millimeters (mm) using the following expression: 1° = 0.1 mm. The penetration readings represent the texture measurements. Analysis of texture results at same cooking temperature but different cooking times. Table 4 summarizes the penetrometer readings at experimental times of 1, 2 and 3 s at 65℃ after 1, 2 and 3 h of cooking. From Table 4, penetration measurements were highest for test time of 3 s thus having the best texture and were lowest for test time of 1 s thus having the worst texture. The penetration measurements for the *Matooke* cooked with polyethylene bags was greater than that measured for the *Matooke* not wrapped in polyethylene bags thus the texture of the *Matooke* improved when it was wrapped in polyethylene bags. The texture after 3 h of cooking was better than the texture after 1 and 2 h. Table 5 summarizes the penetrometer readings at experimental times of 1, 2 and 3 s at 90℃ after 1, 2 and 3 h of cooking. From Table 5, penetration measurements were highest for test time of 3 s thus having the best texture and were lowest for test time of 1 s thus having the worst texture. The texture after 3 h of cooking was better than the texture after 1 and 2 h. The penetration measurements for the *Matooke* cooked with polyethylene bags was greater than that measured for the *Matooke* not wrapped in polyethylene bags thus the texture of the *Matooke* improved when it was wrapped in polyethylene bags. The texture at 90℃ was better than the texture at 65℃. Table 6 summarizes the penetrometer readings at experimental times of 1, 2 and 3 s at 100℃ after 1, 2 and 3 h of cooking. From Table 6, Penetration measurements were highest for test time of 3 s, thus having the best texture and were lowest for test time of 1 s thus having the worst texture as

Table 4. Penetration measured at cooking temperature of 65℃.

Sample code	Time (s)	Penetration with PE (mm)	Penetration without PE (mm)
	1	5.2	4.6
T = 65℃, 1 h	2	5.8	5.4
	3	6.7	6.2
	1	6	5.4
T = 65℃, 2 h	2	6.6	6.2
	3	7.4	6.9
	1	7.7	7.2
T = 65℃, 3 h	2	8.2	7.8
	3	9.1	8.6

Table 5. Penetration measured at cooking temperature of 90℃.

Sample code	Time (s)	Penetration with PE (mm)	Penetration without PE (mm)
	1	6.3	5.8
T = 90℃, 1 h	2	6.9	6.5
	3	8.1	7.6
	1	7.4	6.9
T = 90℃, 2 h	2	8.1	7.7
	3	9.9	9.3
	1	8.4	7.9
T = 90℃, 3 h	2	9.6	8.9
	3	11.8	10.9

Table 6. Penetration measured at cooking temperature of 100℃.

Sample code	Time (s)	Penetration with PE (mm)	Penetration without PE (mm)
	1	6.6	6
T = 100℃, 1 h	2	7.3	6.8
	3	8.6	7.8
	1	8.8	8.2
T = 100℃, 2 h	2	9.6	9
	3	10.3	9.8
	1	11.2	10.5
T = 100℃, 3 h	2	13.3	12.2
	3	14	13

depicted. The texture after 3 h of cooking was better than the texture after 1 and 2 h. The penetration measurements for the *Matooke* cooked with polyethylene bags was greater than that measured for the *Matooke* not wrapped in polyethylene bags thus the texture of the *Matooke* improved when it was wrapped in polyethylene bags. The texture at 100℃ was better than the texture at temperatures of 65 and 90℃.

Conclusion

For color degradation, red, yellow and blue colors were the measured colors. Yellow was the most dominant color. The yellow color measured for the *Matooke* cooked without polyethylene bags was greater than that measured for the *Matooke* wrapped in polyethylene bags at all the three time-temperature combinations thus there was color degradation of the *Matooke* when it's wrapped in polyethylene bags. The yellow color increased with increase in cooking time-temperature combination and was greatest at cooking temperature of 100°C and holding time of 3 h. Penetration measurements for the *Matooke* cooked with polyethylene bags were greater than that measured for the *Matooke* that was not wrapped in polyethylene bags at all the three time-temperature combinations thus the texture of the *Matooke* improved when it was wrapped in polyethylene bags. The measurements were highest for test time of 3 s and were lowest for test time of 1 s at all the cooking time-temperature combinations, but the highest penetration measurement was obtained at a cooking temperature of 100°C and holding time of 3 h for test time of 3 s and lowest at cooking temperature of 65°C and holding time of 1 h for test time of 1 s. Penetration measurements were highest at high temperature and long exposure time combinations thus having the best texture and were lowest at low temperature and long exposure time thus having the worst texture. When *Matooke* is cooked at high temperature and for long exposure time, the texture obtained is very good, however the color of the *Matooke* degrades as compared to low temp and long exposure time.

For future works, further studies should be carried out to investigate the microscopic interactions in changes in color and texture during cooking of *Matooke*. Also food structures in *Matooke* should be studied under different time-temperature combinations to determine whether there are any differences in the expected properties such as taste, feel and the effect it will have on one's appetite.

ACKNOWLEDGEMENT

The authors acknowledge Ms Harriet Namawejje who worked tirelessly to perform these experiments in the various laboratories at Makerere University.

REFERENCES

Banadda N, Namawejje H, Ayaa F, Kigozi JB, Sendagi S (2011). Diffusive flux modeling of lead migration from black polyethylene bags into food: A case study of green bananas (*Matooke).* Afr. J. Food Sci., 5(5): 313-319.

Baoxiu Q, Keith G, John O (2000). Effect of Cooking on Banana and Plantain Texture. J. Agric. and Food. Chem., 4221-4226

Kanetkar VR, Sajilata MG, Singhal RS, Savitha K (2007). Scalping of flavors in packaged foods. Comp. Rev. Food Sci. Food Saf., 6: 17-35.

Kigozi JB, Mulwana C, Banadda N (2010). Assessing the level of chemical contaminant migration and color changes associated with cooking foods in polyethylene bags: A case study of ugali. Afr. J. Food Sci., 4(10): 655-661.

Nicoletta P, Emma C, Claudio G (2010). Effect of different cooking methods on color, phytochemical concentration, and antioxidant capacity of raw and frozen brassica vegetables, J. Agric. Food. Chem., 4310-4321.