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Full Length Research Paper

Effect of using Vegetable Oils - Shea Butter (*Vitellaria paradoxa*) Oil and Coconut Oil as Waxing Material for Cucumber (*Cucumis sativus* L.) Fruits

Tsado, [1]* E. K., Adesina[1], O. A., Adediran[1], O. A., Saidu[1], A., Jiya[2], M. J. and Lawal[1], L. T.

[1]Department of Crop Production, Federal University of Technology Minna, Niger State, Nigeria.
[2]Department of Food Science, Federal University of Technology Minna, Niger State, Nigeria.
*Corresponding Author E-mail: ektsado@yahoo.co.uk

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Cucumber fruits were coated with melted shea butter oil and coconut oil by rubbing it around the fruits and stored for a period of 18 days. The vegetable oils were used to brush the cucumber fruits. The control fruits were kept without any waxing material; the fruits were kept at ambient temperature on the laboratory bench for 3 weeks. During this period the weight and size of the fruits were determined at intervals of 3 days. Pictures of the fruits were taken at 0, 3, 6, 9, 12, 15 and 18 days respectively. The effect of preserving cucumber (*Cucumis sativus*) with different shea butter source on cucumber (*Cucumis sativus*) colour had a significant effect on cucumber (*Cucumis sativus*) colour at 15 DAS and 18 DAS only. Through the study, shea butter oil (processed shea butter oil) among the others were excellent and was seen at every point to be better than the coconut oil and local shea butter waxed cucumber fruits. At the end of the study, it was found out that shea butter is good waxing material that can be used to coat any food material in order to increase its period of storage and market availability in the market.

Keywords: Cucumber fruit, *vitellaria paradoxa*, shea butter oil, coconut oil

INTRODUCTION

Cucumber originated from India and became popular throughout the Egyptian and the Greek-Roman Empire (Renner *et al.*, 2007). Works in the past (Corey *et al.*, 1988; Annon, 2015), have shown that edible coatings not only increase the market opportunity for traders, nut are equally essential in extending the shelf life of the produce. The work of Bett *et al.* (2001), showed that consumer acceptance of coated or uncoated fruits and vegetables have been accepted with mixed feelings. Surveys conducted on consumer perception of whole fruits and vegetables have shown mixed feelings. Few works (Corey *et al.*, 1988; Annon, 2015; Bahnasawy and Khater, 2014) have however also showed that consumers' awareness of coated fruits and vegetables in developing countries like Nigeria is low.

Cucumber (*Cucumis sativus* L.), is the most important cucurbits in terms of world total production compared to water melon (*Citrullus lanatus* L.) and melon (*Cucumis melon* L.). It is an important vegetable crop grown in several temperate and tropical zones of the world. With respect to economic importance, cucumber ranks fourth after tomatoes, cabbage and onion in Asia (Eifediyi and Remison, 2010).

Cucumber (*Cucumis sativus* L.) is a very good source of vitamin A, C, K B6, potassium, pantothenic acid, magnesium, phosphorus, copper and manganese, fibre and antioxidants (Vimala *et al.*, 1999). It helps in healing diseases of urinary bladder and kidney, digestive problems lie heartburn, acidity, gastritis and ulcer (Garcia-Mas *et al.*, 2004). The ascorbic acid and caffeic acid contained in cucumber help to reduce skin irritation and swollen (Okonmah, 2011).

Cucumber (*Cucumis sativus* L.) requires warm temperatures for good yield (Cobeil and Gosselin, 1990).

It develops rapidly, with a shorter time from planting to harvest than for most crops (Wehner and Guner, 2004). It is an all year round out door fruit in the tropic and an important greenhouse especially in Northern Europe and North America.

There exist three main varieties of cucumber; slicing, pickling and burpless. Within these varieties, several different cultivars have emerged. Many cultivars of cucumber exist with varying shapes, skin colors and carotene content (Simon, 1992). Some cucumber cultivars available in Nigeria are Ashley, Royal F1, Pointsett-76, Centriolo Marketer, Market-moore, super-marketer, Beit-alpha etc.

Cucumber (*Cucumis sativus* L.) cultivars have distinctive characteristics/traits which make them suitable for a particular environment of condition in terms of tolerances to drought, disease resistance, early maturing and yield. Production of cucumber in Nigeria is mostly done in the northern part of the country.

There was a general belief that cucumber (*Cucumis sativus* L.) can only be grown in the north. However, cucumber cultivation in the south-eastern Nigeria has been found to be found to be achievable under moderate rainfall (Enujeke, 2013). The crop is now been cultivated in some parts of south-eastern Nigeria. However, the area under cucumber production and the yield per unit area are low (Eifediyi and Remison, 2010; Okonmah, 2011). Farmers in south-eastern Nigeria are often been discouraged from embarking on commercial cucumber production due to high incidence of pests and disease due to extreme temperature, heavy rainfall and high humid condition obtainable in the south which do not favor cucumber production.

Fruit and vegetables are living organisms that obtain their energy through the respiration process after harvest. This postharvest metabolism causes the commodity to ripen and eventually senescence. The positive characteristics that make fruit suitable for consumption also make them susceptible to diseases. During this ripening period, fruits are prone to develop rots caused by microorganisms that hasten commodity ripening, damage their internal and external appearance, because off-odors produce mycotoxins and contaminate adjacent commodities. Although the economic losses due to fungal infection in fruits and vegetables during the postharvest chain are variable and not well documented, they usually reach anywhere from 30 to 50% and on some occasions rots can lead to total loss of the produce. Both fungi and bacteria cause rots however; in general, fungal infections are reported to have a greater ability to infect a broader range of hosts throughout the whole postharvest chain (Bautista-Baños *et al.,* 2016).

To control these fungi and bacteria, commercially-viable alternatives or possible future alternatives to the use of synthetic fungicides and bactericides that either work in combination or alone have been put forward. They include substances such as chitosan (the deacetylated form of chitin) that can be extracted from diverse marine organisms, insects and fungi. It is considered as a biodegradable and bio-compatible material with no toxicity or side effects (Rodríguez-Pedroso *et al.*, 2009).

Younes and Rinaudo, (2015) define the term chitosan 'as a family of polymers obtained after chitin deacetylation to varying degrees'. Lizardi-Mendoza *et al.* (2016) highlight that 'a distinctive feature of the chemical structure of chitosan is the predominant presence of units with amino groups that can be ionized, becoming these groups cationic in acidic media, then promoting the chitosan dissolution and the polyelectrolyte behavior in solution'. Presently, the use of chitosan has been technologically justified in sustainable agriculture programs since it raises no public health and safety concerns. In the fresh produce industry, the regulation EU 2014/563 included chitosan chloride as the first member of a basic substance list of plant protection products (planned with Regulation EU 2009/1107, Romanazzi and Feliziani, 2016).

Chitosan can be found in the shells of marine crustaceans and is also an important component of the cell wall of certain fungi, particularly those belonging to the class Zygomycetes. Chitin can be converted into chitosan by enzymatic preparations or chemical processes. Chemical methods are used extensively for commercial purposes because of their low cost and suitability for mass production.

Over the last decade, chitosan polysaccharide has taken on enormous importance in the control of postharvest pathogenic microorganisms but due to its scarcity and the economy disaster in our country, it has been left unpracticed. The presence of amino groups ($-NH_2$) in its chemical structure gives chitosan unique and ideal food conservation and security properties which are exploited through the development of biodegradable edible coatings and films containing natural antimicrobials; it also has elicitor properties that enhance the natural defenses of fruits, vegetables and grains.

The need and demand for processed fruits and vegetables in markets of developing and developed economies is growing drastically due to changes in new life, serious health concerns or improved power of purchase (Acuff, 1993; McHugh and Sensei, 2000; Jiang and Joyce, 2002).

Waxing, especially for fruits, plays at least two important roles: (i) it provides repellency for water and other solutions for fruit surfaces and (ii) it also reduces the permeability of these solutions through the skin. Water repellency affects the deposition, distribution and retention of chemicals applied to foliage or fruits as solutions or emulsions (Arvanitoyannis and Gorris, 1999).

Reason why waxing is more efficient than any other method of preservation, is that permeability is a major problem when water soluble materials such as calcium need to be introduced into the fruits for desirable effects such as maintenance of firmness.

Waxes prevent moisture loss during fruit storage. Although natural waxes on fruits are effective in preventing water loss, the application of commercial wax can further decrease water loss during prolonged storage.

Fruits and vegetables are highly perishable commodities that require to be handled with much care to minimize losses. Post-harvest losses due to inadequate storage and handling are enormous and can range from 20-50 percent in developing countries (Kader, 1992).

Shea butter is a vegetable fat got from the kernel of the products of the Shea tree (*Vitellaria paradoxa*), a tree having a place with the group of Sapotaceae. The tree is the fundamental indigenous oil delivering wild plant openly developing in Africa (Honfo et al., 2012).

The tree develops wild over a 5000 km wide belt of savanna (Masters et al., 2004), including West Africa nations like Nigeria, Senegal, Mali, Burkina Faso, Togo, Ghana, Benin, Niger, Cameroun, Uganda, Sudan and Ethiopia (Hee, 2011). Four of these nations represent around 600,000MT (application. 80%) of world Shea nut generation.

They incorporate; Nigeria (370.000MT), Mali (85.000MT), Burkina Faso (70.000MT) and Ghana (61.000) (Karen, 2005). Among these nations, Ghana and Burkina Faso are the principal shea nut exporters (Hee, 2011). Nigeria delivers around 50% of worldwide Shea nut production, yet has a tendency to expand the majority of its Shea nuts locally (Karen, 2005).

Methods of preservation of fruits and vegetables during storage and marketing are generally based on refrigeration and use of chemicals (Smith and Stow, 1984; Smith, *et. al.*, 1987; Tasdelen and Bayindirli, 1998). So, chemical storage method and chilling storage method are not economically feasible in most developing countries (Smith *et al.*, 1987; Li and Yu, 2000).

Techniques used in developing countries include use of edible coatings and organic chemicals treatments mainly for greater quality of fresh fruits and vegetables. Edible coatings are a thin layer of edible material enrobed on fruit surface as an addition or a replacement for the natural protective waxy coating (Risch, 2002). So, our local Shea butter coating which is produced cheaply and readily available in Nigeria as used to enrobe the fruits.

Nigeria boosts of different fruits and vegetables but are only available in season. This is attributed to poor harvest handling, post harvest diseases and lack of preservation methods. It is a known fact that fruits and vegetables are perishable and it takes considerable time for a fruits and vegetables produce to reach the table of consumers. During the time consuming process involved in handling, storage and transportation, products start to dehydrate, deteriorate, and lose appearance, flavor and nutritional value. Because of its shorter life, fruits and vegetables on the tables of consumers usually last for few days. If no special protection is provided, the fruits produced will quickly run into deterioration and as such reducing the shelf life and its availability.

The objective of the work was to determine the rate of deterioration at which the waxed (coated) and unwaxed (i.e. uncoated) cucumber fruits will last. It is thought that the micro-organisms associated with the deterioration will also be assessed.

MATERIALS AND METHODS

The research work was carried out in the School of Agriculture and Agricultural Technology Laboratory of the Federal University of Technology Minna, Niger State.

Sources/collection of experimental material

Fresh healthy cucumber fruits (*Cucumis sativus*) were obtained after harvest from Kure along Bosso road, Chanchaga Local Government, Niger State. Processed shea butter oil and coconut oil were gotten from Agric & Bio-resource Department and Kure Market, Minna respectively while local shea butter oil was also obtained in Kure Market, Niger State.

Storage of cucumber fruits (*Cucumis sativus*)

Five (5) ml of vegetable oil (Shea butter oil and coconut oil) were used to polish and wax twenty (20) cucumber fruits. This fruits were kept at ambient temperature on the laboratory bench for three (3) weeks. Control was set without applying either of the oils (i.e shea butter oil and coconut oil).

Shea butter processing

Shea butter oil is an essential vegetable in West Africa. As per Olaniyan and Oje (1999), the cake from which the oil is separated can be utilized as part of the generation of animals sustain.

The customary strategy for getting ready foul shea spread comprises of the accompanying advances:

(a) Separating/splitting: the external mash of the natural product is expelled. Whenever dry, the nut, which is the wellspring of shear margarine, must be isolated from the external shell. This is a social movement, generally done by ladies senior citizens and young ladies who sit on the ground and break the shells with little shakes.

(b) Crushing: To make the shear nuts into margarine, they should be pounded. Generally, this is finished with mortars and pestles. It requires lifting the pestles and pounding the nuts into the mortars to smash the nuts so they can be broiled.

(c) Roasting: The pulverized nuts are cooed in enormous pots over open wood fires. The pots must be blended continually with wooden oars so the spread does not consume. The margarine is substantial and mixing it is hot, smoky work, done under the sun. This is the place the slight smoky posses an aroma similar to conventional shear spread starts.
(d) Grinding: the cooked shear nuts are ground into smoother glue; water is slowly included and the glue is blended well by hand.
(e) Separating the oil: the glue is plied by submit substantial bowls and water is step by step added to help isolate out the margarine oils. As they buoy to the best, the margarine oils, which are curd state, are evacuated and abundance water pressed out. The margarine oil curds are then liquidities in expansive open pots over moderate flames. A time of moderate bubbling will vanish any residual water.
(f) Collecting and shape: The shear margarine, which is rich or brilliant yellow now, is scooped from the highest point of the pots and put in cool spots to solidify. At the point it is shaped into balls.

It can be arranged modernly by utilizing a mechanical sheller or the general nut sheller. The refined spread might be then extricated with chemicals, for example, hexane or by dirt filtration (Fleury, 2000).

Processing of coconut oil

Splitting of the coconuts

Pre-selected, fully matured, husked coconuts without cracks, spongy hautorium, or germinating root/shoot are split into half cup ready for grafting.

Grafting

The fresh coconut kernel is communicated into fine particle and removed from the shell through the usage of motorized direct micro expelling (DME) grater or other types of grater which have now also used by processing.

Drying

The freshly grafted coconut kernel is dried to a moisture content of about 10-11% using direct micro expelling (DME) - designed coconut shell-fired flat-bed conclusion type dryer. This is done spreading batches of 12kg of the grafted kernel thinly on the surface of the dryer. The loaded kernel is often turned by two people positioned on either side of the dryer.

Loading into cylinder

When the grafted kernel is dried to the right moisture content (10-11%) and at the temperature of about 70^0C, it is loaded into direct micro expelling (DME) cylinder through a built-in hop per located on one side of the front end of the dryer.

Oil extraction

The direct micro expelling (DME) cylinder with the dried grafted learned and piston on top is then positioned in the DME press and the lever mechanism pushed sown to compress the loaded grafted kernel in the tube and subsequently release the oil. After the press is done, the spent grafted coconut kernel is pushed out of the tube.

Settling

The oil come out of the direct micro expelling (DME) press has entailed fine particles of dried kernel. These are removed by allowing the oil to clarify by letting it stand for at least two weeks.

Filtration of the oil

After settling, filtration of the oil is done using motorized filtering devices to remove the remaining entrained foots which were not removed during settling.

Organoleptic test

The smell, taste, color and texture of the cucumber fruits (*Cucumis sativus*) will be examined by a panel of five (5) judges every week till the end of the experiment (3weeks). The observation made was recorded during scale voting.

Data analysis

Data collected in the study was subjected to analysis of variance (ANOVA) using statistical analysis (SAS). Means that differs significantly was separated using Duncan Multiple Range Test (DMRT).

RESULTS

The results of the study are presented in (Table 1). There was significant difference in the rate of deterioration between the coated fruits and the control (i.e. uncoated).The four treatments of cucumber fruits (*Cucumis sativus*) that were w axed with coconut oil, processed shea butter oil and local shea oil show longevity in the number of days before their spoilage became obvious in comparison to those that were taken as the control.

Table 1. Effect of vegetable oils on size of the cucumber fruits.

Treatment	TIME					
	3 DAS	6 DAS	9 DAS	12 DAS	15 DAS	18 DAS
Control	227.21[a]	213.72[a]	200.09[a]	191.07[a]	182.47[a]	174.07[a]
Coconut oil	268.02[a]	269.22[a]	229.95[a]	183.61[a]	188.68[a]	150.79[a]
Processed shea butter oil	273.33[a]	268.16[a]	263.61[a]	258.27[a]	249.25[a]	217.40[a]
Local shea butter oil	275.66[a]	270.44[a]	265.48[a]	259.12[a]	243.71[a]	180.64[a]
L S D (0.05)	34.81	35.12	35.36	41.52	38.49	40.36

Means with the same letters within the same treatment group are not significantly different ($p<0.05$) using Duncan multiple test. LSD=Least significant difference, DAS=days after storing.

Table 2. Effect of vegetable oils on the rate of deterioration size of the cucumber fruits.

Treatment	TIME					
	3 DAS	6 DAS	9 DAS	12 DAS	15 DAS	18 DAS
Control	5.30[a]	5.30[a]	5.28[a]	5.27[a]	8.26[a]	5.26[a]
Coconut oil	5.31[a]	5.31[a]	5.29[a]	5.09[a]	5.84[a]	4.82[a]
Processed shea butter oil	5.25[a]	5.25[a]	5.23a	5.42[a]	5.42[a]	5.01[a]
Local shea butter oil	5.07[a]	5.07[a]	5.05[a]	5.04[a]	5.03[ab]	5.02[a]
L S D (0.05)	0.23	0.23	0.24	0.19	0.25	0.31

Means with the same letter(s) within the treatment group are not significantly different ($p<0.05$) using Duncan multiple range test. LSD=Least significant difference, DAS=days after storing.

Rate of deterioration between coated and uncoated fruits

Table 2 shows the effect of vegetable oils on the rate of deterioration size of the cucumber fruits. Day three (3) was the first time the coated fruits were compared with the uncoated fruits. It was seen that the rate of deterioration was slow in the uncoated (control) cucumber fruits whereas it was fast in the coated fruits waxed with coconut oil whereas the two shea butter oil (processed and local) waxed cucumber fruits remained the same with slight changes in color (Figures 1 and 2).

The effect of preserving cucumber (*Cucumis sativus*) with different shea butter source on cucumber (*Cucumis sativus*) colour had a significant effect on cucumber (*Cucumis sativus*) colour at 15DAS and 18DAS only. It was clearly seen that at day 3DAS of examination, there was slight changes in colour of treatment with coconut oil and processed shea butter oil at the tip of each replicates. At day 6DAS, it was observed that treatment with coconut oil started to spoil while others show no difference including the control. At 11DAS, colour begins to change in all treatments while treatment two (coconut oil) continue to rot (Figure 3). At exactly 15DAS, treatment with local shea butter oil started to spoil with colour changes from green to yellow (Figure 4). At the 18DAS it was clearly observed that control (T1) show completely change in colour from green to yellow, coconut oil (T2) spoilage is significant while processed shea butter oil (T3) had slow deterioration rate and slight changes in colour with local shea butter oil (T4) continue to spoil with significant colour changes (Figure 5).

DISCUSSION

From the study it was clearly seen that the rate of deterioration of the coated fruits of shea butter oil was slightly different from coated coconut oil which was not significantly different from the uncoated fruits (i.e control). Even though the examination have mixed thoughts because some of them don't know about shea butter to be edible and some thought it is only used for rubbing hair and skin. But the truth surfaced when its effect in creating a barrier between the fruits and the atmosphere was ascertained and as such extending the shelf life of food materials being enrobed. This is in line with the work of Bett *et al.,* (2001), which show that consumer acceptance of products, especially coated or uncoated fruits and vegetables have been accepted with mixed feelings, few have however, been reported on consumers awareness of coated fruits and vegetables in developing countries like Nigeria. It is in this light that knowing consumers perception towards fresh fruits and vegetables coated with edible material would help the food industry understand consumer attitudes and market demands in developing economies like that of Nigeria where the population is also on the increase.

Studies Hee, (2011), Honfo *et al., (*2012) and Lizardi-Mendoza, *et al., (*2016) have shown that ripening can be retarded, colour changes can be delayed, water loss and decay can be reduced, and appearance can be improved by using a simple and environmentally friendly technology, edible coating (Park *et al.,* 1994; Baldwin et al., 2001). This is true when spoilage was obvious in the uncoated after some days; colour was lost and desiccation

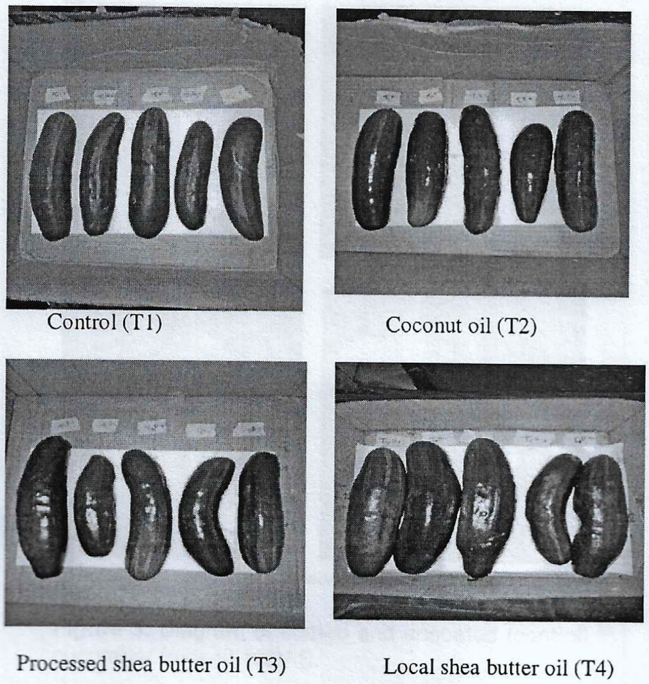

Figure 1. Diagram showing coated and uncoated (control) cucumber fruits at day 0.

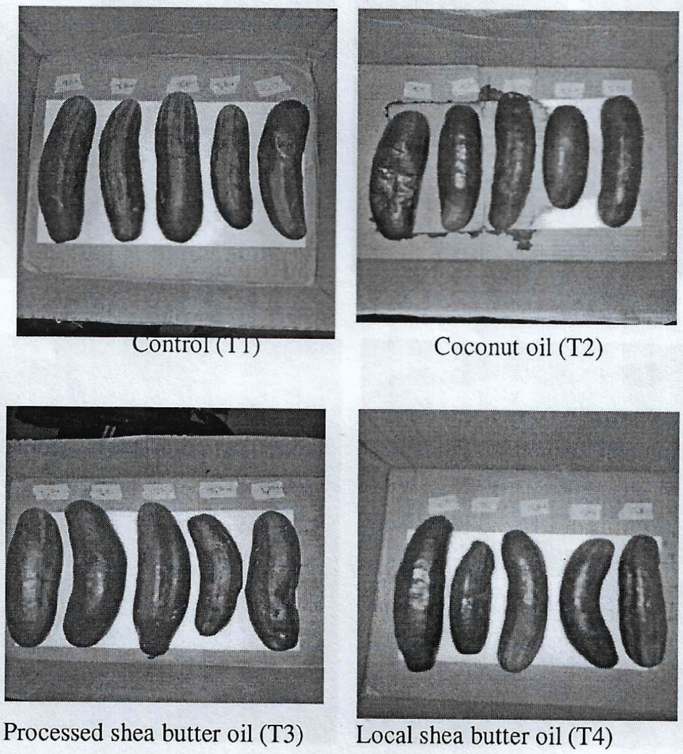

Figure 2. Diagram showing coated and uncoated (control) cucumber fruits at 5DAS.

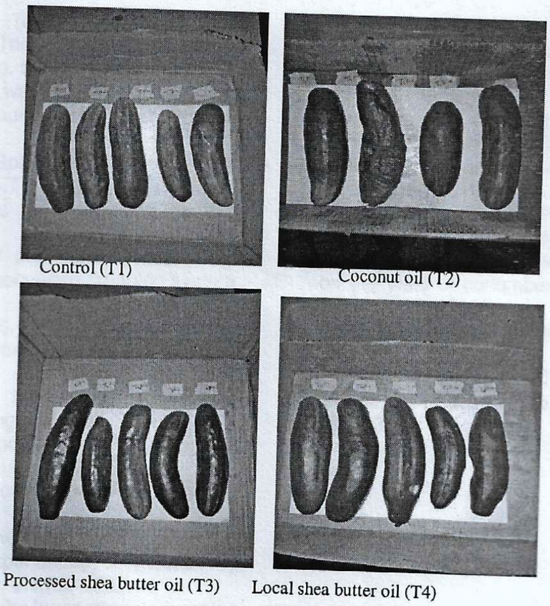

Figure 3. Diagram of coated and uncoated (control) cucumber fruits at 12DAS.

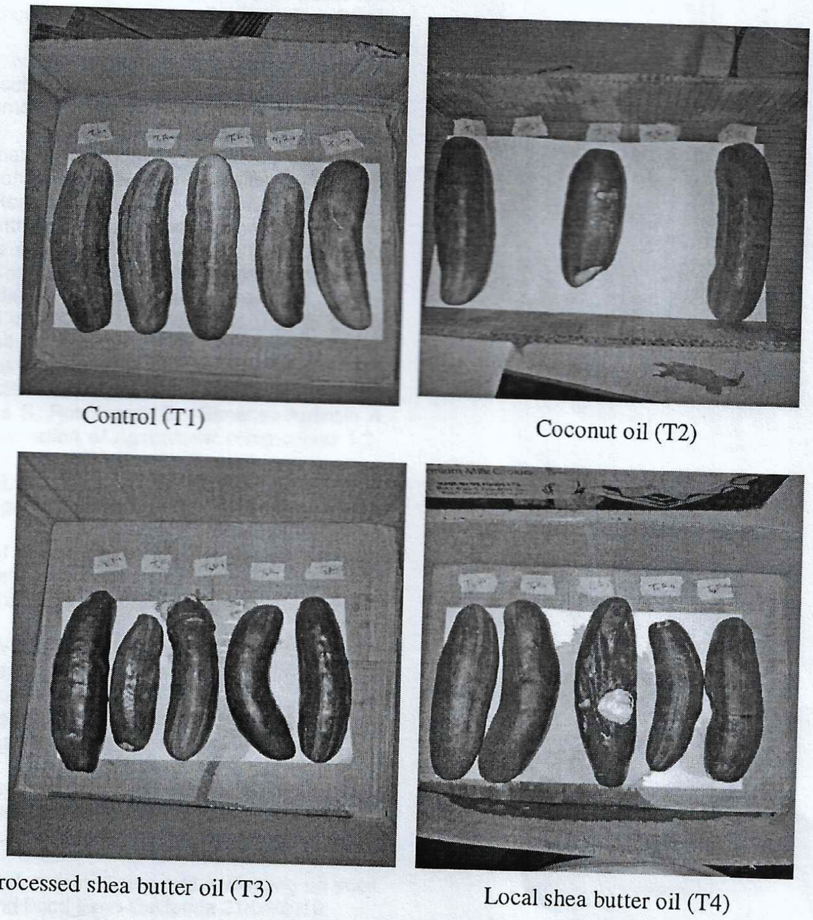

Figure 4. Diagram showing coated and uncoated (control) cucumber fruits at 15DAS.

Baldwin R, Philippe M, Gianmarco O (2001). Global Income Divergence, Trade and Industrialization: The Geography of Growth Take-Offs. Journal of Economic Growth, Pp. 5-37.

Bahnasawy AH, Khater EG (2014). Effect of wax coating on the quality of cucumber fruits during storage. Journal of Food Process Technology. 5: 339-346.

Bett KL, Ingram DA, Grimm CC, Lloyd SW, Spanier, A. M., Miller, J.M., Gross, K.C., Baldwin, E.A., and Vinyard, B.T. (2001). Flavor of fresh-cut gala apples in barrier film packaging as affected by storage time. Journal of Food Quality. 24(2): 141-156.

Cobeil G, Gosselin A (1990). Influence of pruning and season on productivity of cucumber plant grown in a sequence cropping system. Sci. Hortic. 41 (3), 189-200.

Corey KA, Scihimme DV, Channey NA (1988). Changing in epicuticular war on watermelon fruits during ripening. Hort. Science. 23:730-731.

Eifediyi EK, Remison SU (2010). Growth and Yield of cucumber (*Cucumis sativus* L.) as influenced by farm yard manure and inorganic fertilizer. Journal of Plant Breeding and Crop Science. 2(7): 216-220. Enujeke EC (2013). Effects of poultry manure on growth and yield of improved maize in Asaba Area of Delta State, Nigeria, IOSR Journal of Agriculture and Vetinary Science (IOSR-JAVS). 4(5): 24-30.

Fleury RE, Sullivan CM, Bybee DI (2000). When ending the relationship does not end the violence: Women's experiences of violence by former partners. *Voilence Againstn Woman, 6:1362-1383.*

Garcia-Mas J, Monforte AJ, Arús P (2004). Phylogenetic relationships among Cucumis species based on the ribosomal internal transcribed spacer sequence and microsatellite markers. Plant Systematics and Evolution 248: 191-203.

Hee SN (2011). Quality characteristics of West African Shea Butter (*Vitellalia paradoxa*) and approaches to extend shelf life. Unpublished M.sc Thesis Graduate School-New Brunswick Rutgers, The State University of New Jersy.

Honfo FG, Hell K, Akissoe N, Hinnemann A, Coulibaly O (2012). Microbiological and physicochemical characterization of shea butter sold in Benin market. Journal of Stored Products and Postharvest Research, 3(3):24-29.

Kader AA (Ed). (1992). Postharvest Technology of Horticultural Crops (2nd Edition). UC Publication 3311. University of California, Division of Agriculture and Natural Resources, Oakland, California. p.94608.

Karen ESA (2005). Prices and poverty: Agricultural commodities and the position of small scale producers in global economic network. Unpublished M.Sc Thesis Copenhagen Business School, Denmark.

Li H, Yu T (2000). Effect of chitosan on incidence of brown rot, quality and physiological attributes of postharvest peach fruit. Journal of the Science of Food and Agriculture. 81: 269-274.

Lizardi-Mendoza J, Arguelles-Monal WM, Goycoolea-Valencia FM (2016). Chemical characteristics and functional properties of chitosan. In: Bautista-Banos S, Romanazzi G, Gimenez-Aparicio A (Eds), *Chitosan in the preservation of Agricultural commodities* 1:3-31.

Masters P, Duka T, Berris S, Moss G (2004). Koalas on Kangaroo Island: from introduction to pest status in less than a century. *Wildlife Research* 31: 267-272.

Okonmah LU (2011). Effect of different types of staking and their cost effectiveness on the growth, yield and components of cucumber (*Cumumis sativus* L). International. Journal of Agricultural. Science. 1(5): 290-295.

Olaniyan AM, Oje K (1999). Viscoelastic behaiour of shea nuts under compressive loading. Proceedings of the Annual Conference of the Nigerian Institute of Agricultural Engineers. 21, 100-108.

Park HJ, Chinnan MS, Shewfelt RI (1994). Edible cornein-film coatings to extend storage life of tomatoes. Journal. Food Process.Preserv.18. 317-331.

Renner SS, Schaefer H, Kocyan A (2007). Phylogenetic of Cucumis (Cucurbitaceae): Cucumber (*Cucumis sativus*) belongs in an Asian/Australian clade far from melon (*Cucumis melo*). BMC Evolutionary Biology 7:58.

Risch SJ (2002). Impact of product formulation and packaging on shelf life. 2002 Annual Meeting and Food Expo-California 21/04/2010.

Smith SM, Stow JR (1984). The potential of a sucrose ester coating material for improving the storage and shelf-life qualities of Cox's Orange Pippin apples. Annals of Applied Biology. 104: 383-391.

Smith SM, Geeson J, Stow J (1987). Production of modified atmospheres in deciduous fruits by the use of films and coatings. Horticultural Science. 22(5): 772-776.

Tasdelen O, Bayindirli L (1998). Controlled atmosphere storage and edible coating effects on storage life and quality of tomatoes. Journal of Food Processing and Preservation. 22 (4): 303-320.

Vimala P, Ting CC, Salbiah H, Ibrahim B, Ismail L (1999). Biomass production and nutrient yielods of four green manures and their effect on the yield of cucumber. Journal of Tropical Agriculture and Food Science. 27: 47055.

Wehner TC, Guner N (2004). The genes of watermelon. Horticultural Science 39:1175-1182.

Younes I, Rinaudo M (2015). Chitin and chitosan preparation from marine sources structure, properties and application. Marine drugs 13: 1133-1174.