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POTENTIAL OF GINGER(*Zingiber officinale)* EXTRACTS ON SHELF LIFE OF EGG PLANT *(Solanum melogena L.)*

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ABSTRACT

The laboratory experiment was conducted at the laboratory of the Department of Crop Science and Biotechnology, Imo State University, to investigate the effects of ginger extracts used as preservatives on the shelf-life of Solanum melongena. The experiment was arranged in a Completely Randomized Design with four replications and four treatments which include various concentrations of ginger extract (50mg, 100mg and 200mg) with an untreated plots which served as the control. The freshly harvested fruits were cleared and treated with the various parameters which included ambient temperature, daily weight and weight loss, fruit firmness and colour change. The fruits were taken for proximate analysis at the end of the study and acceptability assessment was also conducted based on a 9 point hedonic scale. Statistical analysis of the data showed that 100mg ginger extracted fruits were better accepted on the bases of fruit firmness, aroma and palatability. Results also showed that ginger extract did not influence weight loss significantly. However, the highest dietary fibre, fat, protein and ascorbic acid (10.30%, 70.20%, 2.60% and 6.90% respectively) were obtained from the 100mg ginger extract treated fruits. It was concluded that application of ginger extract at 100mg concentration was best for the extension of the shelf life of egg plant.

Keywords: Solanum melongena, Ginger extract, shelf life, storage

I. INTRODUCTION

Solanum is a very large and important genus of the family *Solanaceae.* The egg plant *(Solanum melongena L.)* is one of this genus which is representative of the non-tuberous group of *Solanum* species. It has potential wild types with resistance to different biotic and abiotic stress (Behera and Singh, 2002). *Solanum melongena* is an important vegetable in Central, Southern and Southeastern Asia and in a number of African countries (Behera *et al.,* 2006). Egg plants are cultivated in all the agroecological zones of Nigeria and there are many varieties of egg plant. Each variety is peculiar to the locality where it is cultivated (Ubani and Okonkwo, 2011). The egg plant is characterized by variation in morphology, physiology and biochemical features such as bitterness of fruit (Daunay *et al.,* 2001).

It is well known that storage of fruits and vegetables at low temperature from harvest till consumption is an effective means for preserving quality and nutritional from tropical areas like egg plant are chilling sensitive below 10^0C. Egg plants suffer physiological disorders manifested mainly by appearance of surface injuries such as pitting and scald, seed darkening and flesh browning (Concellon *et al.,* 2007). Egg plant quality and shelf life are reduced by development of skin and tissue browning when stored at chilling temperatures. Food preservation is more than engineering and its proper understanding must involve the relationship between engineering, nutritional, biochemical, microbiological, entomological and economic aspects of preservation. Only the amalgam of these can be considered to encompass food preservation as a whole. Under tropical and

sub-tropical conditions, most crops deteriorate rapidly after harvest ceasing to be marketable (Ubani and Okonkwo, 2011).

The major disadvantages of food produce storage and distribution are the limits it imposes on shelf-life. The difficulty in predicting storage life of different perishable crop varieties. There is lack of control over distribution conditions which occur in the Nigerian situation especially in the local markets (Ubani and Okonkwo, 2011). Although the egg plant has been identified to be an important vegetable crop which list of importance include both nutritional and medicinal values. The fruits are claimed to alleviate liver ailments and it is a fruit of choice by diabetic patients (Lawande and Chavan, 1998).

Egg plant deterioration starts within two to three days after harvest, especially when the stalk and calyx are removed and fruits are exposed to warm temperatures (Ubani and Okonkwo, 2011). The problem of wastage of fruits during the peak season is enormous, especially in transporting to the marketing outlets as well as holding at the retail points in both urban and rural markets. The present study was therefore aimed at investigating the effects of ginger extracts used as preservatives on the shelf-life of *Solanum melongena.*

II. MATERIALS AND METHODS

Location

This study was conducted in the laboratory of the Department of Crop Science and Biotechnology and at the Teaching and Research Farm of the Faculty of Agriculture and Veterinary Medicine, Imo State University, Owerri. Owerri lies between the latitudes $5^0$10'N and $6^0$0'N and longitudes $6^0$35'E and $7^0$0'E with an altitude of 91.0m within the Southeast rain forest agricultural zone of Nigeria. The area maintains an average annual rainfall of 2500mm, mean minimum and maximum temperature of 23.5^{0}C and 32.1^{0}C respectively, with relative humidity ranging from 70-85% and the annual evapotranspiration is 1450mm (NIMET, 2010).

Source of Materials

Materials was used in this study were collected from Imo State University Teaching and Research Farm, while chemicals to be used for extract were collected from Department of Crop Science and Biotechnology Laboratory but not limited to the following: A variety of egg plant to be collected from the local market in Owerri.

A piece of land measuring 3m x 10m ginger, rhizomes, blender, weighing scale, 34 pieces of small plastic basket with lid, and three tray pan.

Phase I of the Study

The experimental plot measured 10 x 10 plots. The plots was cleared manually using a cutlass. The egg plants were sown at the depth of 2-3cm and planting distance 25cm within rows and 50cm between rows. The field was kept weed free throughout the growing period and NPK 15:15:15 fertilizer was applied at a common rate of 25kg/ha. The purpose of planting this crop was to harvest fresh fruits for the laboratory study (Phase II).

Phase II (Laboratory study)

Preparation of the Botanical Extracts

The ginger rhizomes were cleaned by washing thoroughly to remove soil particles. The rhizomes were chopped into smaller pieces and spread on the tray pan and placed outside for sun drying. The sample was allowed to dry for 72hours and then crushed using the electric blender. The

sample was cruched. After crushing, the sample was passed through a 24-meash sieve to get a fine powder. The sieved samples will be stored in air tight containers.

Experimental Design

The 17 pieces of the small plastic baskets with lid containing egg plant were arranged in a Completely Randomized Design with four replications.

Treatments and Treatments Application

The sieved botanical extracts formed the treatment for the study in the following rates:

1.	Control	=	Treatment 1 (T_1)
2.	100g	=	Treatment 2 (T_2)
3.	250g	=	Treatments 3 (T_3)
4.	350g	=	Treatment 4 (T_4)

Freshly harvested egg plant fruits were cleaned and weighed 25 fruits each was selected at random and placed in each of the plastic baskets lined with perforated polyethene material. Each of the specified treatments were applied at the rates of 100g, 250g and 350g. The baskets was covered with the lid and allowed to stand at room temperature. The laboratory experiment stood stand for 14 days.

Data Collection

The experiment was allowed to stand while it was monitored and data was collected on the following parameters:

1. **Ambient Temperature (^{0}C):** The temperature in the baskets was taken daily and recorded.
2. **Colour Change:** the fruits were observed daily to detect and record the date from storage date till when change in the original colour will occur. Digital photography was also taken daily.
3. **Fruit Firmness:** The fruits were observed by feeling to detect shriveling in their texture.
4. **Weight loss (%):** The fruits were weighed daily and weight loss was calculated from the difference between initial and final weight and expressed as zero percentage of the initial fresh weight.
5. **Fruit Decay (%):** This was determined by counting the number of decayed fruits (with either pathological or physiological disorders) and expressed as a percentage of the initial number of fruits per each sample (replicate) for each treatment.
6. **Ascorbic Acid (Vitamin C) content:** This was calculated as mg/100 ml juice as described in AOAC (1990).
7. **Palatability Test:** This was conducted at the end of the experiment for fruit flavor and acceptability. Twenty students from the Department of Food Science Technology were sampled and were given the fruits to confirm for aroma and acceptability on a 9 point Hedonic scale (1-9) where;

1. Extremely dislike
2. Dislike very much
3. Dislike moderately
4. Dislike slightly
5. Neither like nor dislike
6. Like slightly
7. Like moderately
8. Like very much
9. Extremely like

Data Analysis

The data collected were subjected to statistical analysis using the analysis of variance method suitable for the CRD as described by Onuh and Igwemma, 2007).

III. RESULTS

Initial and Daily Weight of Garden Egg in Storage

The highest (243.77g) mean initial weight of fruit was recorded from the fruits that were treated with 100mg of ginger extract. This showed significant difference from the mean recorded from the 200m of ginger extract treated fruits. However, it was statistically at par with the 238.75 and 237.47mg mean initial weight, recorded from the control and 50mg ginger extract treated plots (Table 1).

Day 2 results showed that there was no significant difference in the weight of the fruits in storage. However, the fruits that received 50mg of ginger extract treatment recorded the highest (234.24g) mean fruit weight while the lowest (227.56g) mean fruit weight was recorded from the 200mg ginger extract treated fruits (Table 1).

Similarly, at Day 4 and 5 the 50mg ginger extract treated fruit recorded the highest (225.87 and 222.64) respectively which were not significantly different (P<0.05) from the lowest (220.07 and 217.92g) mean fruits weights recorded from the 200mg ginger extract treated weight recorded from the 200mg.

Table 1: Effects of ginger extract on the daily weight of eggplant fruits in storage

Treatment	Initial weight DAY 1	DAY 2	DAY 3	DAY 4	DAY 5	DAY 6
Control (T_1)	238.75^{ab}	233.87	229.47	224.44	220.80	218.76
50mg (T_2)	237.47^{ab}	234.24	229.38	225.87	222.64	218.56
100mg (T_3)	243.77^{a}	231.94	228.38	223.88	222.06	219.06
200mg (T_4)	233.47^{b}	227.56	223.72	220.07	217.92	215.07
LSD	9.18	ns	ns	ns	ns	ns

N/B: ns = not significant, mean in the same column having the same letter(s) not significantly different (P<0.05)

Weight Loss per Day

The results showed that at Day 2 in storage, the highest (591g) mean weight loss of fruit was recorded from the plots that received 200mg of the ginger extract treatment.

However, this did not show significantly difference (P<0.05) from the means obtained from the other treatments while the fruits treated with 100mg had the lowest (1.83g) mean weight loss compared to the control that recorded 4.88g mean weight loss detail is presented in Table 2.

At Day 3 a similar trend to that of Day 2 was observed but at Day 4, the 50mg ginger extract treated plots recorded the highest (4.76g) mean fruit weight loss which did not show significant difference (P<0.05) from the lowest (3.64g) mean weight loss of fruit which was obtained from the 200mg ginger extract treated fruits (Table 2).

At Day 5, the 50mg ginger extract treated fruits, recorded the lowest (1.8g) mean weight loss compared to the highest (3.64g) mean weight loss recorded from the control (Table 2).

Similarly, at Day 6, the control fruits recorded the highest (4.04g) mean weight loss which the 50mg ginger extract treated fruits recorded the lowest (100g) mean weight loss which were significantly different (P<0.05) from the other mean (See details in Table 2).

Table 2: Effects of ginger extract treatment on the weight loss of fruits

	Mean daily weight loss (g)				
Treatment	**DAY 2**	**DAY 3**	**DAY 4**	**DAY 5**	**DAY 6**
Control (T_1)	4.88	4.39	5.02	3.64	4.04
50mg (T_2)	3.64	3.61	4.76	3.22	2.08
100mg (T_3)	1.83	4.15	4.50	1.81	1.00
200mg (T_4)	5.91	3.84	3.64	2.15	2.77
LSD	ns	ns	ns	ns	ns

N/B: ns = not significant, mean in the same column having the same letter(s) not significantly different ($P<0.05$)

Fruit Firmness and Colour Change

Table 3 showed that the fruits that received ginger extract treatment, retained firmness throughout the study, however, it was observed that at Day 4 the fruits in the control started losing firmness progressively till the end of the study (Table 3).

Colour change was observed starting from the Day 2 in the control fruits and this change in colour progressed by day and at Day 6 100% of the fruits in the control had changed colour. Colour change was at 50% in the treated plots at Day 6 (see details in Table 3). The temperature of the storage environment was common in all the treatments (25.5^0C).

However, no fruit decay was observed.

Table 3: Effects of ginger extract treatment on the fruit firmness and colour change of the fruits

		Fruit firmness	**Colour change (%)**	**Fruit Decay**	**Average Ambient (^{0}C)**
	Control (T_1)	+	20%	Nil	25.5^0C
	50mg (T_2)	+	0	Nil	25.5^0C
DAY 1	100mg (T_3)	+	0	Nil	19.41
	200mg (T_4)	+	0	Nil	28.55
	Control (T_1)	+	45	Nil	25.5^0C
DAY 2	50mg (T_2)	+	10	Nil	25.5^0C
	100mg (T_3)	+	10	Nil	17.31
	200mg (T_4)	+	15	Nil	29.25
	Control (T_1)	-	100	Nil	27.25
DAY 3	50mg (T_2)	+	20	Nil	27.25
	100mg (T_3)	+	20	Nil	16.22
	200mg (T_4)	+	20	Nil	30.5
	Control (T_1)	-	100	Nil	25.75
DAY 4	50mg (T_2)	+	40	Nil	25.25
	100mg (T_3)	+	30	Nil	15.25
	200mg (T_4)	+	40	Nil	33.25
	Control (T_1)	-	100	Nil	25.25
DAY 5	50mg (T_2)	+	50	Nil	25.25
	100mg (T_3)	+	30	Nil	05.25
	200mg (T_4)	+	55	Nil	30.25^{0c}

Acceptability

The acceptability test conducted on a 9 point hedonic scale showed that 15 out of twenty student rated the fruits treated with 100mg of ginger extract as 8 on the hedonic scale which was the highest significantly different (P<0.05) rating while 3 student rated the same 100mg extract treated fruit as 6 while 2 student rated 2 compared to the 200mg ginger extract treated fruits which was rated 5 by ten students, 6 by three students 2, 3 and 4 by two students each while one student rated 1. For the fruits treated with 50mg ginger extract, fifteen students rated them 5 while two students rated 4 and one students rated 6, three students rated 2 while four students each rated 3 and 4 (Table 4).

Table 4: Acceptability of eggplant fruits based on aroma on a hedonic scale

	HS 1	HS 2	HS 3	HS 4	HS 5	HS 6	HS 7	HS 8	HS 9
Control (T_1)	-	3	4	4	-	10	-	-	-
50mg (T_2)	1	-	1	2	15	-	1	-	-
100mg (T_3)	-	-	-	-	2	3	-	15	-
200mg (T_4)	1	2	2	2	10	3	-	-	-

NB: HS = Hedonic scale
HS 9 … HS 9. Hedonic scale 1… Hedonic scale 9

Proximate Analysis

The dietary fibre from the freshly harvested fruit was the highest (11.20) significantly difference (P<0.05) fibre content compared to the control with recorded 10.30.

Dietary Fibre

The fruits that received 100mg extract treatment gave 10.30% dietary fibre which did not show significant difference (P<0.05) from the 11.20% recorded from the freshly harvested fruits. The control recorded 9.60% fibre which did not differ significantly (P<0.05) from the 9.30% fibre recorded from the fruits that received 50mg of ginger extract. However, the fibre content recorded from the freshly harvested fruits was significantly different (P<0.05) from all the fibre content recorded from the other treatment plots while the fruits that received 200mg of ginger extract recorded the lowest (8.90%) mean fibre content (Table 5).

Fat Content

The highest (7.20%) fat content from the treated fruits was recorded from the 100mg ginger extract treated fruits. This showed significant difference (P<0.05) from the fat content in other treatments. However, the freshly harvested fruits recorded the highest (8/10%) fat content while the 50mg treated fruits recorded the lowest (5.70%) fat content (Table 5).

Protein Content

The highest (2.90%) protein content recorded from the freshly harvested fruits showed the significant differences from the lowest (1.80%) protein content, recorded from the control fruits. The fruits that received 100mg ginger extract treatment recorded 2.60% of protein while the 200mg and 50mg of ginger extract treated fruits recorded 20 and 2.4% protein content respectively (Table 5).

Protein Content

The highest (2.90%) protein content recorded from the freshly harvested fruits showed the significant difference from the lowest (1.80%) protein content, recorded from the control fruits. The fruits that received 100mg ginger extract treatment recorded 2.60% of protein while the 200mg and 50mg of ginger extract treated fruits recorded 20 and 2.4% protein content respectively (Table 5).

Ascorbic Acid

The ascorbic acid content of the freshly harvested fruit was 1.40% which did not show significant difference (P<0.05) from the other ascorbic levels. The fruits that received 100mg ginger

extract recorded the highest (6.90%) ascorbic acid which also did not showed significant difference (P<0.05) from the lowest (1.40%). The control fruits recorded (1.90%) ascorbic acid (Table 5).

Moisture Content

The highest (44.20%) moisture content in fruit was recorded from the control fruits which showed significantly difference (P<0.05) from the other moisture contents recorded. The lowest (38.40%) moisture content was recorded from the fruits that received 50mg ginger extract treatments. However, the freshly harvested fruits recorded 43.40% protein content (Table 5).

Ash Content

The highest (40.00%) ash content was recorded from the fruits that were treated with 100mg of ginger extract. This did not show significant difference (P<0.05) from the ash content recorded from the freshly harvested fruits. However, it was significantly different (P<0.05) from the lowest (30.00) mean ash content recorded from the control (Table 5).

(pH)

The pH value of the freshly harvested fruits was 6-5 which showed significant difference (P<0.05) from the pH values recorded from the treated fruits while the control recorded the highest (7.3) mean pH value, the 50mg ginger extract plots recorded 6.9, while the 100mg and 200mg ginger extract treated fruits, recorded 6.8 and 7.2 pH values respectively (Table 5).

Table 5: Effect of ginger extract on the proximate analysis of stored eggplant fruits

Treatments	Dietary fibre (%)	Fat (%)	Protein (%)	Ascorbic acid (%)	Moisture content (%)	Ash (%)	pH
Control (T_1)	9.60^{b}	6.20^{d}	1.80^{c}	1.90^{a}	44.20^{a}	30.00^{b}	7.30^{a}
50mg (T_2)	9.30^{b}	5.70^{e}	2.40^{abc}	2.40^{a}	38.40^{e}	36.00^{ab}	6.90^{c}
100mg (T_3)	10.30^{ab}	7.20^{b}	2.60^{ab}	6.90^{a}	42.00^{c}	40.00^{a}	6.80^{d}
200mg (T_4)	9.80^{c}	6.50^{c}	2.00^{bc}	2.60^{a}	40.30^{d}	36.00^{ab}	7.20^{b}
Freshly harvested	11.20^{a}	8.10^{a}	2.90^{a}	1.40^{a}	43.40^{a}	34.10^{ab}	6.50^{e}
LSD	1.0	0.0	0.75	ns	0.75	9.61	0.0

N/B: ns = not significant, mean in the same column having the same letter(s) not significantly different (P<0.05)

IV. DISCUSSION

The result of storage and its statistical analysis revealed that the fruits of eggplant stored with 100mg ginger extract was as good in nutritive value as the freshly harvested fruits. It was observed that there was significant difference in nutritive value of fruits in the control when compared to the treated fruits. However, very meager nutritive changes were observed when the fruits were treated with varying concentration of ginger extract. These changes were pronounced with the 200mg ginger extract treated fruits. This reduction in nutritive value observed in the 200mg ginger extract treated fruits could be attributed to the increased temperature observed in the storage which according to Rajkumari and Archana (2014) reduces the nutritive value of stored vegetables.

The increased temperature observed in the storage especially with the 200mg of ginger extract may be associated with microbial activities in the closed system.

Invariably, this increased temperature could be responsible for the rapid colour change observed in the 200mg ginger extract treated plots. Comparing with the 100mg ginger extract treated fruits where colour change was relatively show per day compared to the control. Colour change in the control was about 70% faster in the control than in the ginger extract treated fruits. This observation points to the fact that although, the ginger extract have shown great potentials in extending the shelf life of stored fruits of eggplant, the concentration at which storage. The

concentration is important to consider its effects on storage temperature, according to Aquin-Bolan *et al.* (2000).

Irrespective of the temperature rise and colour change, it was observed that unlike in the control fruits which lost firmness from the third day in storage, the ginger extract treated fruits maintained firmness throughout the period of storage regardless of the concentration.

Again, the physical appearance of the fruits further suggest that 100mg was appropriate for the actualization of improved shelf-life and also maintenance of nutritive value.

Generally, according to the result, there was no significant difference in the weight loss of the fruits treated with varying concentrated of ginger extract and those in the control. On the acceptability assessment, the results showed that based on the 9 point hedonic scale, the fruits that received the 100mg of ginger extract treatment was most accepted for its aroma and taste with 15 out of 20 students according that it was the best.

V. CONCLUSION

The results presented above and the accompany discussion has brought to the fore the potentials of ginger extract in the extension of the shelf life of eggplant and maintenance of nutritional contents in storage. Therefore, within the limits of this study, it suffice to say that, application of ginger extract at 100mg was able to improve or extend the shelf life of stored fruits of eggplant, as well as exhibited fungicidal potentials as there were no incidence of rot of decay.

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