CHAPTER ONE

INTRODUCTION

Banana (*Musa sp*.) is an important fruit crop world wide. Bananas are grown in more than 150 countries, producing 105 million tons of fruit per year. The global production of banana is around 102028.17 thousand tons (FAOSTAT, 2006). Bananas are today grown in every humid tropical region and constitute the 4 largest fruit crop of the world, following the grape, citrus fruits and the apple (Morton, 1987).

Banana is a popular fruit in Sudan and considered one of the most important cash crops. It is well adapted to warm dry weathers and its productivity exceeded 50 tones/ hectare under light fertile soil of the Gash river basin and the Nile River banks of Sudan (FAOSTAT, 2009).

Banana plays a dual role as a food staple in the tropics. It is an important source of food and income to small-scale household all year around. Banana fruits can be eaten fresh or cooked; the trunk and leaves can be fed on livestock and there are other different uses including wrapping food and making ropes and mats (Nelson *et. al.*, 2006; Pillay and Tripathi, 2007). In Sudan, banana ranks first in terms of volume and second after citrus, in terms of value (Bakhiet, 2006).

Banana fruits are popular and it grown along the banks of the Nile and its tributaries. Kassala area considered to be the main producing area of banana in Sudan. Banana main cultivar grown in Sudan is the Dwarf Cavendish. (Sudan Trade Point, 2015). The common feature of banana production in the Sudan was a mixed farm system and smallholdings of

pure stand depending on irrigation from wells and rivers (Bakhiet, 2006). Banana production faced many challenges, one of the most important problems is the losses after harvest. Post harvest diseases and spoilage of the fruits are the most effective problems that affect the shelf life of the banana fruits, world wide and in Sudan as well.

Pesticides are considered indispensable for sustainable agriculture production, in addition to their role in the protection of human health especially in the tropics. (Karan, *et.al* 2006).

Meanwhile, the increasing and irrational use of synthetic pesticides has become a source of great concern because of their possible effect on human health and non-target components of the environment (Akimbo, and Carvel, 2004). This concern is heightened by the non-specificity and high toxicity of some pesticides and development of resistant strains of microorganisms against other ones. The foregoing has initiated the exploration of safe alternate antimicrobial agents. Accordingly, increasing effects have been primary directed towards minimizing pesticides risks in the environment through ecologically sound innovative measures of diseases control (Guideword, et.al, 1990).

Recently, the uses of natural products for crop protection were greatly emphasized by scientists in everywhere (Guideword, *et.al*, 1990). Medicinal plants have become the focus of intense study in terms of validation of their traditional uses, and then it can be used as natural pesticides. These pesticides are generally more selective in their action, economically feasible and less harmful to the environment than synthetic chemicals. (Songhua and Michailides, 2005).

Hence the purpose of this study is to find a way to prolong the shelf life of the banana fruits in Sudan and lessen the hazards of using chemicals.

Objectives:

The aim of this work is to find an alternative to chemicals currently used in the lengthen of the shelf life of the plant products.

In this work, we intended to use natural products in treating banana fruits aiming at prolonging their shelf life.

CHAPTER TWO

LITERATURE REVIEW

2.1 Banana plant

Banana (*Musa sp*.) is an important fruit crop world wide. Bananas are grown in more than 150 countries, producing 105 million tons of fruit per year. The global production of banana is around 102028.17 thousand tons (FAOSTAT, 2009). Bananas are today grown in every humid tropical region and constitute the 4 largest fruit crop of the world, following the grape, citrus fruits and the apple (Morton, 1987).

Banana is a popular fruit in Sudan and considered one of the most important cash crops. It is well adapted to warm dry weathers and its productivity exceeded 50 tones/ hectare under light fertile soil of the Gash river basin and the Nile River banks of Sudan (FAOSTAT, 2006).

In some countries, bananas used for cooking may be called plantains, in contrast to dessert bananas. The fruit is variable in size, color and firmness, but is usually elongated and curved, with soft flesh rich in starch covered with a rind which may be green, yellow, red, purple, or brown when ripe. The fruits grow in clusters hanging from the top of the plant. Almost all modern edible parthenocarpic (seedless) bananas come from two wild species – *Musa acuminata* and *M. balbisiana*. The scientific names of most cultivated bananas are *Musa acuminata, Musa balbisiana, and Musa* × *paradisiaca* for the hybrid *Musa acuminata* × *M. balbisiana*, depending on their genomic constitution. The old scientific name *Musa sapientum* is no longer used. (Morton, 2009).

Musa species are native to tropical Indomalaya and Australia, and are likely to have been first domesticated in Papua New Guinea. They are grown in 135 countries, primarily for their fruit, and to a lesser extent to make fiber and as ornamental plants (ref.).

2.1.1 Scientific classification

Kingdom::Plantae
Division: Magnoliophyta
Class: Magnoliopsida
Family: Musaceae
S.N: *Musa sp.*

2.1.2 Postharvest Problems

Banana production faced many challenges, one of the most important problems is the losses after harvest. Post harvest diseases and spoilage of the fruits are the most effective problems that affect the shelf life of the banana fruits, world wide and in Sudan as well.

Bananas must be transported over long distances from the tropics to world markets. To obtain maximum shelf life, harvest comes before the fruit is mature. The fruit requires careful handling, rapid transport to ports, cooling, and refrigerated shipping. The goal is to prevent the bananas from producing their natural ripening agent, ethylene. This technology allows storage and transport for 3–4 weeks at 13 °C (55 °F). On arrival, bananas are held at about 17 °C, and then treated with a low concentration of ethylene. After a few days, the fruit begins to ripen and is distributed for final sale. Unripe bananas can not be held in home refrigerators because they suffer from the cold. Ripe bananas can be held

for a few days at home. If bananas are too green, they can be put in a brown paper bag with an apple or tomato overnight to speed up the ripening process (Picq *et al*, 2000).

2.2 Ginger plant (*Zingiber officinale*)

Ginger (*Zingiber officinale*) is widely used around the world in foods as a spice. For centuries, it has been an important ingredient in Chinese herbal medicines for the treatment of catarrh, rheumatism, nervous diseases, gingivitis, toothache, asthma, stroke, constipation and diabetes (Tapsell, *et al*., 2006). Several reviews have appeared in the literature about this plant, and this may reflect the popularity of the subject and its common use as a spice and a medicinal plant (Afzal *et al*., 2001; and Chrubasik *et al*., 2005).

2.3.1. Scientific classification

Kingdom: Plantae
Subkingdom: Tracheobionta
Super division: Spermatophyte
Division: Magnoliophyta
Class: Liliopsida
Subclass: Zingiberidae
Order Zingiberales
Family Zingiberace
Genus: *Zingiber*
Species: *Z. officinale*
Binomial name: *Zingiber officinale*
(Wikipedia.com).

2.3.2 Plant distribution

Ginger plants have known to originate in South East Asia, probably in India (Burkill, 1990). One of the species under this group is. *Zingiber officinale* that is known to possess markedly high antioxidant potential compared to other species studied till date (Nan-Chen *et al*., 2008), is cultivated in several countries such as in Australia, Bangladesh, Haiti, Jamaica, Japan, Nigeria, Sri-Lanka, and South East Asian countries including China, Nepal, Malaysia, North Korea, Indonesia and India (Wu and Larsen, 2000). In addition to availability under cultivation, large populations of these plants are also available as land races in the wild, with Eastern and North-Eastern India. Rhizomes of the plants are used as spice whereas both rhizomes and leaves provide important source of medicine. Several landraces of *Zingiber officinale* have been identified by local communities to be elite with respect to medicinal and spice value (Sanjeev *et al*.,2011).Some of genotypes of *Zingiber officinale* are particularly valued for their non-fibrous rhizomes that are likely to provide high content of bio-molecules in the higher content of soft tissue (Kizhakkajii and Sasikumar, 2011). Being vegetative propagated by rhizomes that constitute the plant part for spices and medicines, such plants run the risk of over exploitation in the wild, this adds to the urgent need for Documentation Evaluation and Conservation of these plants. Understanding genome profiling vis-à-vis antioxidant (medicinal) potential of wild population of ginger plants for screening hitherto unexplored medicinal plants that would help to bring underutilized germplasm to cultivation focus, would repay careful investigation.

2.3.2.1 Medical Important

Ginger and many of its chemical constituents have been shown, in numerous clinical studies, to be useful in combating several metabolic diseases. Badreldin, *et al*. (2007) mentioned the document and comment on the publications that have appeared on ginger and its constituents in the last 10 years or so. The papers reviewed provide another example of how it may be possible to explain the actions of folk medicines in terms of conventional biochemistry and pharmacology. Ginger and many of its chemical constituents have strong anti-oxidant actions. As several metabolic diseases and age-related degenerative disorders are closely associated with oxidative processes in the body, the use of either ginger or one or more of its constituents as a source of anti-oxidants to combat oxidation warrants further attention , and post- operative vomiting and vomiting of pregnancy. It may be worthwhile investigating the effect of ginger on vomiting during cancer chemotherapy, as the crude drug and its constituents have themselves anti-cancer actions. Ginger is considered a safe herbal medicine with only few and insignificant adverse side effects (Badreldin, *et al*. 2007).

CHAPTER THREE

MATERIAL AND METHODS

This study was conducted under laboratory condition of Plant Pathology, College of Agricultural Studies, Sudan University of science and Technology during the period March 2017 to investigate the effect of the ethanolic extracts of ginger rhizomes on the shelf life of banana fruits.

The argel leaves were collected from bahri Market and then the fruits were treated under the laboratory condition where temperature around 25c. material toad and equipment used in the study orang fruits-glaves –camera-

All material except argel extracts were cleaned by drop water and sterilized by ethanol.

3.1 The experiment

We brought the orange fruits from Khartoum market. The fruits are free of any infection. The fruits were then treated by ethanolic extract of argel leaves by three different concentration 100% -50%-25% with three replicates compared to untreated fruits. Then the results were statistically analyzed using the randomized complete design.

3.2. Plant Material

Dried argel leaves were crushed and ground with mortar and pestle.

3.3. Preparation of extracts

Extracts from leaves of Coriander (*Coriandrum sativum)* and ginger roots (*Zingiber officinale)*, were obtained or collected from local market in Khartoum "Shambat" , Sudan and tested for their efficacy in reducing the mycelial growth of *A. solani in vitro* using the poisoned food technique (Schmitz, 1930).

Powdered plant materials were sequentially extracted with different solvents in a **Soxhelt** apparatus for 8h according to the method described by (Pandey, 2007). The solvents used for extraction included petroleum ether (PE), ethanol (ET). The respective extracts were filtered and dried under reduced pressure using rotary evaporator to yield solid/semisolid residues. The residues were lyophilized to get dry solid mass.

3.4. Experimental design:

The experiment was arranged in a Complete Randomized block Design.

3.5. Statistical analyses:

The obtained data was statistically analyzed according to analysis of variance (ANOVA) Duncan's Multiple Range Test (DMRT) was used for means separation using Mstat-C statistical package.

CHAPTER FOUR

RESULTS AND DISCUSSION

4.1 Effect of ginger rhizomes ethanolic extracts on the shelf life of banana fruits

Table (1) shows that no significant difference was recorded within the treatments or when compared with the control in the first two days after treatment.

On the other hand, a significant difference (P=0.05) was recorded within the treatment and when compared to the control. It is obvious that the concentration 25% significantly prolong the shelf life of the banana fruits up to 5 days.

These results is similar to the results obtained by other researchers (ref.).

Table 1. The effect of ethanolic extract of Ginger on the shelf life of banana fruits compared to the untreated control

TREATMENTS	DAY1	DAY2	DAY3	DAY4	DAY5
Ginger extract 100%	100[a]	100[a]	50[c]	10[c]	1[c]
Ginger extract 50%	100[a]	100[a]	75[b]	50[b]	5[b]
Ginger extract 25%	100[a]	100[a]	100[a]	75[a]	20[a]
Control	100[a]	100[a]	50[c]	10[c]	1[c]
SE	0	0	6	8	2
CV	0	0	3	7	12

-Means with the same letter in the same column are not significantly different ($P < 0.05$)

REFERENCES

Afzal, A., D., Menon, M., Pesek, J. and Dhami, M.S.2001.Ginger: an ethno medical, chemical and pharmacological review. Drug Metab. Drug Interact.18, 159–190.

Badreldin, H.A., Gerald B., Musbah O.T. and Abderrahim, N. (2007). Some phytochemical, pharmacological and toxicological properties of ginger (Zingiber officinale Roscoe): A review of recent research.

Bakhiet, S. B. (2006). “Evaluation of Introduced Cavendish Banana (Musa AAA) Clones Grown at Kassala, Sudan”. Ph. D. (Agric). Thesis, University of Gezira, Wad Medani, Sudan.

Burkill, I. H. (1990). A Dictionary of the Economic Products of the Malay Peninsula, Kuala Lumpur, Ministry of Agriculture and Co-operatives.

Chrubasik, S., Pittler, M.H. and Roufogalis, B.D. (2005). Zingiber is rhizome: a comprehensive review on the ginger effect and efficacy profiles. Phytomedicine12, 684–701.

FAOSTAT. (2009). Food and Agriculture Organization of the United Nations.

Kiran, B. and Raveesha, A.K. (2006). Antifungal activity of seed extract of Psoraleacorylifolia l. plant Disease Research, 20:213-215.

Kizhakkayil, J., & Sasikumar, B. (2011). Diversity, characterization and utilization of ginger: a review. Plant Genetic Resources, 9, 464-477.

Morton J. (2009). "Banana from 'Fruits of Warm Climates'. Hort.purdue.edu. Archived from the original on 2009-04-15. Retrieved 2009-04-16.

Nan Chen,I., Chen-Chin, C., Chang-Chai, N., Chung-Yi, W., Yuan-Tay, S., & Tsu-Liang, Chang. (2008). Antioxidant and Antimicrobial

Activity of Zingiberaceae Plants in Taiwan. Plant Foods Hum Nutr, 63, 15-20.

Nelson, S.C., Ploetz, R. C. And Kepler, A. K. (2006). "Musa species (bananas and plantains). In: Elevitch, C. R. (ed.). Species profile for pacific island Agro forestry permanent agricultural recourses, Holualoa Hawai'i

Pandey, A.K. (2007). Anti-staphylococcal activity of a pan-tropical aggressive and obnoxious weed Parthenium histerophorus: an in vitro study. NatlAcadSciLett2007, 30:383-386.

Picq, Claudine & INIBAP, eds. (2000). Bananas (English ed.). Montpellier: International Network for the Improvement of Banana and Plantains/International Plant Genetic Resources Institute. ISBN 978-2-910810-37-5. Retrieved 2013-01-31.

Pillay, M. And Tripathi, L. (2007). Banana. Chapter 15. In: Kole,C. (Ed.).Genome Mapping and Molecular Breeding in Plants. Volume 4 Fruits and Nuts. Springer-Verlag, Berlin pp. 281301.

Purseglove, J. W., Brown, E. G., Green, C. L. & Robbins, S. R. J. (1981). Spices Vol.2. Longman Inc. New York

Sajeev, S., Roy, A. R., Iangrai, B., Pattanayak, A., & Deka, B. C. (2011). Genetic diversity analysis in the traditional and improved ginger (Zingiber officinale Rosc.) clones cultivated in North-East India. Scientia Horticulturae, 128(3), 3182-188.

Schmitz, H., (1930). Poisoned Food Technique. 2nd Edn. Industry of Engineering Chemical, London, USA. pp: 333-361.

Tapsell, L.C., Hemphill, I., Cobiac, L., Patch, C.S., Sullivan, D.R., Fenech, M., Roodenrys, S., Keogh, J.B., Clifton, P.M., Williams, P.G., Fazio, V.A. and Inge, K.E.(2006). Health benefits of herbs and spices: the past, the present, the future. Med. J. Aust. 185(Suppl. 4), S4–S24

Wu, T. L., & Larsen, K. (2000). Zingiberaceae. Flora of China, 24, 322-377.

Appendices

Descriptive Statistics

	RED1	RED2	RED3	RED4	RED5
N	12	12	12	12	12
Missing	0	0	0	0	0
Sum	1200	1200	825	435	81
Mean	100.00	100.00	68.750	36.250	6.7500
SD	0.0000	0.0000	21.651	28.930	8.1701
Variance	0.0000	0.0000	468.75	836.93	66.750
SE Mean	0.0000	0.0000	6.2500	8.3513	2.3585
C.V.	0.0000	0.0000	31.492	79.806	121.04
Minimum	100.00	100.00	50.000	10.000	1.0000
Maximum	100.00	100.00	100.00	75.000	20.000

Statistix 8.0 9/18/2017, 4:19:34 AM

Descriptive Statistics

	RED1	**RED2**	**RED3**	**RED4**	**RED5**
N	12	12	12	12	12
Missing	0	0	0	0	

Sum	1200	1200	825	435
Mean	100.00	100.00	68.750	36.250
SD	0.0000	0.0000	21.651	28.930
Variance	0.0000	0.0000	468.75	836.93
SE Mean	0.0000	0.0000	6.2500	8.3513
C.V.	0.0000	0.0000	31.492	79.806
Minimum	100.00	100.00	50.000	10.000
Maximum	100.00	100.00	100.00	75.000

Statistix 8.0 9/18/2017, 4:21:28 AM

Completely Randomized AOV for RED1

Source	DF	SS	MS	F	P
TREM	3	0.00000	0.00000	M	M
Error	8	0.00000	0.00000		
Total	11	0.00000			

Grand Mean 100.00 CV 0.00

WARNING: The total sum of squares is too small to continue.
The dependent variable may be nearly constant.

Completely Randomized AOV for RED2

Source	DF	SS	MS	F	P
TREM	3	0.00000	0.00000	M	M
Error	8	0.00000	0.00000		
Total	11	0.00000			

Grand Mean 100.00 CV 0.00

WARNING: The total sum of squares is too small to continue.
The dependent variable may be nearly constant.

Completely Randomized AOV for RED3

Source	DF	SS	MS	F	P
TREM	3	5156.25	1718.75	M	M
Error	8	0.00000	0.00000		
Total	11	5156.25			

Grand Mean 68.750 CV 0.00

WARNING: The model error mean square is too small to continue.
The model may fit the data exactly.

Completely Randomized AOV for RED4

Source	DF	SS	MS	F	P

TREM	3	9206.25	3068.75	M	M
Error	8	0.00000	0.00000		
Total	11	9206.25			

Grand Mean 36.250 CV 0.00

WARNING: The model error mean square is too small to continue.
The model may fit the data exactly.

Completely Randomized AOV for RED5

Source	**DF**	**SS**	**MS**	**F**	**P**
TREM	3	734.250	244.750	M	M
Error	8	0.00000	0.00000		
Total	11	734.250			

Grand Mean 6.7500 CV 0.00

WARNING: The model error mean square is too small to continue.
The model may fit the data exactly.