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Research Article

Potatoes Sprout Suppressant Activity of Essential Oils of *Monodora tenuifolia*, *Cymbopogon citratus* and *Ocimum gratissimum*

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Abstract Storage of potato for a long time is very challenging because of sprouting. Sprouting affects the quality of table potatoes and reduces their availability to within a few months after harvest. Short time availability of potatoes after harvest is not economical. The use of synthetic chemical such as chlorpropham to suppress potato sprout growth is very effective but environmentally unfriendly. Thus, any treatment that uses natural products to inhibit sprout growth and extend shelf life of potatoes could be beneficial. This research was conducted to investigate the potentiality of three essential oils to suppress potato sprouting during storage. Essential oils were extracted from *Monodora tenuifolia, Ocimum gratissimum and Cymbopogon citratus* by hydrodistillation in Clevenger-type-apparatus and analyzed for potato sprout inhibitory activity. The essential oils were screened using tomato seeds and the results revealed that the three oils were promising potato sprout suppressants. The dust formulations of these oils were then prepared using alumina, bentonite and kaolin. Each formulation contained 300 mg of essential oil in 5 g of the adsorbent. 1 kg of potatoes was held in each cardboard box (30 x 22 x 11 cm) and the dust formulation was applied to the contents of the box. All boxes containing the treated potatoes were kept in a dark room at ambient temperatures for 12 weeks. At the end of the 12th week, sprout lengths were measured and the data obtained were subjected to statistical analyses. *Ocimum gratissimum* oil was the most active essential oil against potato sprouting followed by *Cymbopogon citratus oil*. This study showed that *Ocimum gratissimum* oil significantly inhibited sprouting of potato in storage at room temperature, and therefore could be used to prepare potato sprout suppressant. Bentonite proved to be the best adsorbent for essential oil formulation that would slowly release the oil for a long time.

Keywords Potato, essential oil, sprouts suppressant, storage

Introduction

It is fundamental that countries where food crisis is prevalent should have a primary goal of improving their food production and storage system to achieve food security, attain self-sufficiency and to provide raw materials for their local industries. Meeting the global food security requirement demands a multi-national collaborative effort to integrate the best research from science, engineering and socioeconomics so that technological advances can bring benefits where they are most necessary [1].

Potato (*Solanum tuberosum* L.) is the world's most important non-grain food crop and is crucial to global food security [2]. Potato belongs to the family *Solanaceae* and includes over 2,000 species among which *Solanum tuberosum* L. is the most popular. This species, *Solanum tuberosum* is cultivated all over the word and most frequently in the moderate climate zone. Inca Indians first cultivated potato in 200 B.C. as their staple food, which they called papa [3]. Early sprouting is one of the significant problems facing stored potato tubers intended for processing as a result of relatively high temperature (25 °C) requirement for storage [4]. Higher temperature encourages sprouting and causes major losses in stored tubers. Potatoes naturally form sprout 30-140 days after harvest. Respiration of tubers and breakdown of dormancy during storage result in sprouting and loss of nutritive values of potato tuber [5]. Sprouts change potato tubers into sugar which prepare them for the new growth. Also sprouting decreases the weight, the nutritional and processing quality of tubers and the number of marketable potatoes, which accounts for weighty economic losses during potatoes storage [6].

Chemical application, timely harvesting, proper curing and maintain optimal environmental conditions are various methods growers use to control sprouting during storage. The primary method used to control sprouting of potatoes in storage is the postharvest application of isopropyl *N*-(3-chlorophenyl) carbamate (Chlorpropham or CIPC), which inhibits sprout development by interfering with cell division [7-9]. Chlorpropham is a synthetic pesticide with excellent sprout suppression. However, due to environmental concerns and safety of potato consumers, it is advisable to discourage the use of CIPC.

Nowadays, it is very important to use natural products compounds such as essential oils as well as the pure compounds derived from essential oils [10-11]. Research undertaken at University of Idaho has shown that essential oils of clove, spearmint and peppermint can control potato sprout organically. National occurring compounds could be used as alternative potato sprout inhibitors based on the common idea that natural products are less harmful to the environmental than synthetic chemical products [12]. Therefore, it is worthful investigating potato sprout inhibitors from natural source in order to proffer solution to the global environmental harm posed by synthetic sprout suppressants. The aim of this research is to study the effect of three essential oils extracted from *Monodora tenuifolia, Cymbopogon citratus and Ocimum gratissimum* on stored potatoes.

Materials and Methods

Materials: *Ocimum gratissimum* leaves and *Cymbopogon citratus* were obtained from a home garden while *Monodora tenuifolia* and tomato seeds were purchased in local Market in Nigeria. Potato tubers *(Solanum tuberosum L.)* of uniform diameter of 50–70 mm were purchased from local Farmer in Nigeria immediately after harvest. Alumina and kaolin used in this research were obtained from Geology Departmental Laboratory, University of Technology Akure while bentonite was obtained from Ondo State UNICEF Assisted Water and Sanitation Project Site Oba-Ile Road, Akure.

Extraction of Essential Oils: 350g each of fresh leaves of *O. gratissimum*, grasses of *C. citratus* or air dried and pulverized seeds of *M. tenuifolia* samples were subjected to hydrodistillation for 4hr using a Clevenger-type apparatus in accordance with the British pharmacopoeia specification [13]. The oils were stored in sealed glass bottles and kept in refrigerator.

Screening of Essential Oils: A measured volume of essential oil (0.1 mL, 0.3 mL, 0.5 mL, 1.0 mL) was placed on the inside of a Petri-dish lid and allowed to form film on the surface of the lid. A Whatman No.1 filter paper was used to cover the base of the Petri-dish and 15 tomato seeds were placed on the paper. The seeds were evenly spaced and 4mL of water was added to the content of the Petri-dish. The chemically coated lid was eventually used to cover the Petri-dish. The Petri-dish and its contents were kept in a dark room at room temperature for 4 days after which the tomato root and shoot lengths were determined.

Sprout suppressant formulation and treatment: 1kg of healthy and uniform size potato tubers was held in loosely covered cardboard box (30 x 22 x 11 cm). 5g of a carrier (alumina, kaolin or bentonite) was weighed into a beaker containing 300mg of each essential oil (*Monodora tenuifolia, Cymbopogon citrates or Ocimum gratissimum*). The content of the beaker was thoroughly mixed to form the sprout suppressant formulation. Each box contents were evenly dusted with the prepared formulation and the box was covered with a loosely fitting lid. Three controls were also set up as described above but without essential oil treatment. However, each control was dusted with one of the carriers. Three essential oils and three carried were used in this research. The procedure above was carried out for each essential oil and a carrier in triplicate (n = 3). The temperature inside the boxes throughout the period of experiment varied from 25 °C to 37 °C. The application of essential oil treatment was based on the technique of Oladimeji 1983 [14].

Statistical Analysis: All analysis were carried out in triplicates (n = 3) and results were presented as mean ± standard deviation. Data were also subjected to students *T* test and to analysis of variance (ANOVA) to determine their significant differences.

Results and Discussion

Table 1 summarizes the parts of plant used, colour oils and percentage oil yields of *M. tenuifolia, C. citratus* and *O. gratissimum*. The yield of essential oils from *M. tenuifolia*, *C. citratus* and *O. gratissimum* extracted by hydrodistillation in percentage (v/w) were 0.61, 0.59 and 0.57 respectively. The oil yield was highest in *M. tenuifolia* and lowest in *O. gratissimum*. These values are higher compare with the results obtained by Akintayo *et al*., (2011) [15] for *P. racemosa* oil (0.56%) and by for *M. spicata* (0.33%) and *M. cardiaca* (0.41%). These values are in agreement with the finding of Jasim *et al*., (2007) [16] which indicated that seeds of plant contain more essential oil than leaves or other plants. The result of percentages oil yield revealed that these plants could produce enough essential oils to justify their commercial cost of extraction.

Table 1: Parts of plant used, colour of oil and percentage oil yields of *M. tenuifolia, C. citratus and O. gratissimum*

Plant	Part of plant	Colour of oil	% yield
M. tenuifolia	seeds	yellowish brown	0.61
C. citratus	grasses	pale yellow	0.59
O. gratissimum	leaves	pale yellow	0.57

Table 2: Shoot lengths of tomato seeds stored for a period of 4 days

Oils	Tomato Shoot Length^b (mm)			
	Amount of Oil applied per dish (mL)			
	0.1	**0.3**	**0.5**	**1.0**
Control	9.22±4.17	26.1±7.25	25.17±5.81	11.4±5.52
M. tenuifolia	NSG	NSG	NSG	NSG
C. citratus	NSG	NSG	NSG	NSG
O. gratissimum	NSG	NSG	NSG	NSG

^{b}values are mean ± SD. NSG = NO shoot growth

Table 3: Root lengths of tomato seeds stored for a period of 4 days

Oils	Tomato Shoot Length^b (mm)			
	Amount of Oil applied per dish (mL)			
	0.1	**0.3**	**0.5**	**1.0**
Control	12.11±6.94	23.0±10.55	13.5±3.10	13.3±6.88
M. tenuifolia	NRG	NRG	NRG	NRG
C. citratus	NRG	NRG	NRG	NRG
O. gratissimum	NRG	NRG	NRG	NRG

^{b}values are mean ± SD. NSG = NO Root growth

Table 2 and Table 3 show the shoot lengths and root lengths of tomato seeds treated with the three essential oils. The result in the two tables showed that no shoot and root growths were observed on the tomato seeds treated with *M. tenuifolia, C. citratus or O. gratissimum* oils after 4 days. However, length of shoot and root growths of the control ranged from 11.4-26.1mm and 12.11-23.0mm respectively. The result from the screening of oils clearly shows that the three essential oils used in this research successfully inhibited the germination of tomato seeds. This indicates that *M. tenuifolia, C. citratus and O. gratissimum* are promising potential sprout suppressants as report by Oladimeji 1983 [14]. Table 4 shows the lengths of the longest potato sprouts after treatment with sprout suppressant formulation from essential oils used in this research. The sprout lengths for potato tubers obtained from alumina, bentonite and kaolin dusted controls were 15.50, 15.51 and 15.56mm respectively. These values are not significantly different ($p \leq 0.05$). This result suggests that the three carriers on their own have no effect on sprouting of potatoes and that whatever sprout suppression observes in this research is entirely due to essential oils.

The length longest of the longest sprouts for *M. tenuifolia* oil formulations with 15.90, 14.60 and 15.30mm respectively. These values are not significantly different ($p \geq 0.05$). It is noteworthy that values of the longest sprouts in controls and those obtained from treatments with *M. tenuifolia* oil formulations are not significantly different as shown in Table 2.4. Thus, it can be inferred from these results that *M. tenuifolia* essential oil may not be an effective potato sprout suppressant which used in dust formulation.

The lengths of the longest for *C. citratus* oil formulations with alumina, bentonite and kaolin were 15.20, 12.10 and 15.00mm respectively. At $p \geq 0.05$, there is no significant different between the values obtained for alumina and kaolin but the value for bentonite carrier was significantly different at $p \leq 0.05$. This result suggests that *C. citratus* may be a potential potato sprout suppressant and could be at its best in the dust formulation using bentonite as carrier.

The sprout lengths in *O. gratissimum* formulations with alumina, bentonite and kaolin were 8.30, 10.20 and 17.40mm respectively. Formulation of this very oil in kaolin had the highest value followed by formulation in bentonite, while alumina formulation the lowest value.

Table 4: Sprout lengths of potatoes stored for a period of 9 weeks

Oil Formulation	**^{k} Length of the Longest Sprout (mm)**
Control:	
Alumina	^{a}15.50 ± 0.09
Bentonite	^{a}15.51 ± 0.26
Kaolin	^{a}15.56 ± 0.47
M. tenuifolia/alumina	^{a}15.90 ± 0.43
M. tenuifolia/bentonite	^{a}14.60 ± 0.72
M. tenuifolia/kaolin	^{a}15.30 ± 0.54
C. citratus/alumina	^{a}15.20 ± 0.16
C. citratus/bentonite	^{b}12.10 ± 0.94
C. citratus/kaolin	^{a}15.00 ± 0.24
O. gratissimum/alumina	^{c}8.30 ± 0.15
O. gratissimum/bentonite	^{d}10.20 ± 0.99
O. gratissimum/kaolin	^{e}17.40 ± 0.24
LSD at 5% level	1.55

Data are mean values ± SD of triplicates

^{k}Values with similar letters are not significantly different.

However, at $p \leq 0.05$, there are significant differences between these values; thus, suggesting that *O. gratissimum* oil when used with alumina, bentonite, or kaolin may be a highly potent potato sprout inhibitor.

It is important to note that *O. gratissimum* oil in kaolin produced sprout length that was higher than those in the controls. This result was not unexpected since according to an earlier report published by [19], delay in subsequent applications after initial treatment may result in greater sprout than if no oil was applied. Effectiveness of any essential oil in potato sprout control is linked to its rate, timing, frequency and method of applications, cultivar, storage temperature and management [19]. The results in Table 3.4 also revealed that dust formulations for each oil in bentonite had the lowest sprout growths in all treatments. This implies that bentonite may be a better carrier that regulates the rate of release of oil over a longer period than alumina and kaolin.

Conclusion

This research provides some evidences to potato sprout suppressant treatments of some essential oils. From the results obtained, applications of *O. gratissimum* oil on potato tubers produced the lowest sprout lengths and therefore had the greatest significant effect on potato sprout suppressant. The study proved that *O. gratissimum* oil was a better potato sprout inhibitor compared to *M. tenuifolia and C. citratus* oils. *C. citratus* oil on the other hand showed considerable promise as much as potential potato suppressant which *M. tenuifolia* oil had no effect on the potato sprouting.

Further investigation is required to optimize release rate of applications, timing, frequency and method of applications in high temperature storage, and also to determine the chemical composition of the essential oils.

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