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Bioactive Jute Fabrics for Packaging and Storage of Grains and Legumes Applications

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RECENTLY, anti-microbial finishing of cellulosic based material gain interest from both scientific and industrial point of view. Anti-microbial food packaging is a system that is able to kill or inhibit the growth of microorganisms contaminating with foods. Direct contact of antimicrobial food packaging fabrics with incubated foodstuff inhibit the growth of microorganism to large extend. This would increase the shelf life of foods and decrease the risk of food borne illness. In this work, jute fabrics were functionalized to provide permanent bioactivity for packaging and storage application especially for grains and legumes was develop and investigated. Swatches from the scoured jute fabrics were treated separately with chitosan (1 % aqueous solution) (substrate I), chitosan and neem extract (substrate II), triclosan (substrate III) and reactive cyclodextrin (R-CD) followed by neem extract (substrate IV). Treated and untreated fabrics were monitored for antibacterial and anti-anthropoids properties. Results obtained showed that, jute fabrics treated with chitosan and neem extract exhibit antibacterial activity towards both S. aureus and E. Coli compared with the untreated one. Moreover, untreated jute fabric did not shows any deterrent effect toward Callosobruchus maculates, whereas all treatments show a sharp decrement in average number of hatching eggs and average number of adults after 7 days of incubation but with different degree. Higher decrement in average number of hatching eggs and adults was observed when jute fabrics treated with a chitosan in the presence of neem (substrate II) and those fabrics treated with R-CD in the presence of neem (substrate IV) were used as packaging for cowpea. The deterrent effect reached to 100 % against Callosobruchus maculates.

Keywords: Antimicrobial, Cotton fabric, Cellulose, Food package, Functional finishing, Insect repellent.

Introduction

Antimicrobial packaging is a system for incubating foodstuff and is able to kill or prevent the growth of microorganisms contaminating with foods [1-6]. Polymer with ideal antimicrobial should have the following characteristics:(i) inexpensive and easily synthesized (ii) long-term storage and usage stability at the temperature of its intended application (iii) water insoluble (iv) regenerates when loss of its activity (v) shouldn't be toxic or irritating to those who are handling it (vi) biocidal character toward pathogenic micro-organisms' broad spectrum in brief times of contact (vii) stable and do not emit toxic products[7-11].

Over the last decade, several studies were carried out to develop coating polymers having antimicrobial properties and safe to utilize as packaging for food. Chitosan was utilized as a coating for protecting fresh fruits and vegetables from fungal degradation [12].

Arthropod (mainly mite and insects), acarid mites (Acari: Acaridae) *e.g., Acarus siro* L., *Tyrophagous putresentiae* (Schrank) and *Carboglyphus lactis* L. are among the economically important pests infesting stored product and food stuffs even herbal medicinal plants[13]. Some of these mites are well documented as allergen producers and causing

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not only heavy damage to food, but also causes human acariasis such as dermatitis and allergy.

Chitosan polymer considered a versatile and promising biodegradable polymer for the packaging of food. Furthermore, chitosan has a great potential as antimicrobial packaging polymer due to its non-toxicity and antimicrobial activity. improving of Functional properties for chitosan films can be done by combining it with other film forming materials [14].

A variety of plant and spice based antimicrobials are used to eliminats or reduce pathogenic bacteria, in addition to increase the overall quality of food products[15-17].

The demand for fresh ready-to-eat food products and globalization of food trade as well as distribution from industrial mill pose major challenges for food safety and quality. In Moreover, the increasing antibiotic resistance of some pathogens associated with food borne illness is another anxiety [18]. Therefore, developing novel types of effective and nontoxic antimicrobial treatment for packaging system to protect the incubated or stored food against infection actually represent challenge.

Several studies were made to investigate the antimicrobial activities of some plant essential oils (EOs) [19-23]. It has been found that, its antimicrobial properties are specific towards each micro-organism. Therefore, the selection of antimicrobial agents is dependent on their efficacy against a target microorganism.

The objective of the present study is to develop new generations of cellulosic-based products (fabrics) functionalized to provide permanent bioactivity for food packaging applications. The bioactive functionalization of the fabrics will involve three different and specific applications, namely: antimicrobial activity, microbial sensor and insect or arthropod repellent. Each function will be directed to the recommended type of food application. The newly developed active packaging will monitored to satisfy food safety regulations, which are different in each country.

Materials and Methods

Materials

Sodium hydroxide, sodium carbonate, acetic acid were of laboratory grade chemicals. Chitosan was supplied from Vanson Inc., USA. It has a degree of deacetylation equal to 82.9%, and an average molecular weight of 160,000 Da. Egyptol® (non-ionic wetting agent based on an ethylene oxide condensate). Monochlorotriazinyl-β-cyclodextrin, referred to here as reactive β-cyclodextrin (R-CD), was provided by Waker Chemie GmbH, Germany. Neem extract was supplied from Ministry of Agricultural, Cairo, Egypt. Triclosan (2,4,4-trichloro-2-hydroxydiphenyl ether) under a commercial name (Tinosan AM100), was supplied from Ciba Specialty Chemicals, Egypt.

Plate count agar (PCA), Nutrient agar (NA), Czapeks-Dox yeast extract agar (CDYEA), Malt extract agar (MEA) Baird-Parker agar (BPA), Buffered peptone water (BPW), Selenite broth (SB), Brilliant green agar (BGA), were purchased from Difco (Difco labs., Detroit, Michigan, USA). MacConkey agar (MCA), Eosin methelene blue agar (EMBA), Kanamycin aesculine azid agar (KAAA), Mannitol-egg yolk polymyxin agar (MEYPA), Tryptic soy broth (TSB), Tryptic soy agar, (TSA), Muller Hinton agar, (MHA) and Malt extract agar (MEA) were obtained from Oxide (Oxide Comp., Basigstoke, Hants, UK).

Grey jute fabric was kindly supplied from Jute Company, Cairo, Egypt. The fabric was scoured using an aqueous solution containing NaOH, 40 g/l, Egyptol®, 5 g/L, at 95^{o}C for 30 min. The fabric was then washed several times with boiling water then washed with cold water and finally dried at ambient conditions.

Methods

Treatment procedures

Treatment of jute fabrics with chitosan and neem extract: A known weight of chitosan was dissolved in an aqueous 1% acetic acid solution under mechanical stirring for 15 min. Jute fabrics were padded in two depth and nips in chitosan solution then squeezed to a wet pick-up of 100%. The jute fabrics were then dried at 85^{o}C for 5 min then cured at 100–160^{o}C for 1–5 min. Finally, the samples were washed with water at room temperature and dried at ambient conditions. Jute fabric treated with this method was designated as (substrate I).

For a set of chitosan treated fabrics, further treatment with alcoholic solution of neem extract (1 wt %) for one hour then squeezed and dried at ambient conditions. Jute fabric treated with this method is designated as (substrate II)

Treatment of Jute fabric with Triclosan: Scoured Jute fabric was padded in an aqueous solution containing 1 % Triclosan (Tinosan® AM100), at pH 2-7. pH was adjusted using 1% formic acid. The fabric was then squeezed to a wet pickup of 100% using a laboratory padding machine, dried at 80^{o}C for 5 min, then cured at 120^{o}C for 3 min in a laboratory oven. The fabric was then washed several times with cold water and dried under ambient conditions. Jute fabric treated with this method was designated as (substrate III)

Reaction of jute fabrics with Monochlorotriazinyl-β-cyclodextrin (R-CD) followed by neem extract: Treatment of jute fabric with R-CD was carried out using the pad-dry-cure method according to the following conditions: The jute fabric was padded in two dips and two nips in an aqueous solution containing R-CD (100 g/l) and sodium carbonate (30 g/l), and then squeezed to a wet pick-up of about 100 %. The jute fabric was dried at 85°C for 5 min and then cured at 160°C for 3 min. The fabric was washed with cold water containing 1% acetic acid, followed by several washing cycles and finally dried under the normal ambient conditions.

The so obtained Jute fabrics that bearing cyclodextrin (CD) moieties was allowed to react with alcoholic solution of neem extract (1 wt %) for one hour then squeezed and dried at ambient conditions. Jute fabric treated with this method was designated as (substrate IV).

Testing and analysis

Antibacterial activity test: Control and treated jute samples were tested for their antimicrobial activities against Staphylococcus aureus as Gram-positive bacteria *E. Coli* as Gram-negative bacteria. Microorganisms were supplied from the Department of Microbial Chemistry, Division of Genetic Engineering and Biotechnology, National Research Centre, Cairo, Egypt. The cultural medium used was prepared by mixing the following constituents: glucose, 10 g/L; yeast extract, 3 g/L; meat extract, 1.5 g/L; NaCl, 0.5 g/L and agar 20 g/L. The pH of the cultural medium was adjusted at 7 then sterilized at 120 °C for 30 min under pressure. Antibacterial activity was estimated according to AATCC Standard Test Method [24]. The previously mentioned medium was poured in sterile Petri dishes (20 ml for each plate) and left to cool. These plates were inoculated with the test organism and left for 2 hr. Discs of jute fabric samples (10 mm in diameter) were introduced to the plates with a sterile forceps and gently pressed to insure good contact with the solid medium. The plates were then kept in the refrigerators at 5 °C for 1 hr to permit good diffusion before transferring them to an incubator at 37 °C for 24 hr. The inhibition zones (mm) were then measured.

Microbial count test:

Microbiological examination: The microbiological examinations of spices and herbs samples included the determination of total mesophilic aerobic counts, thermophilic bacteria, yeast and mold counts, *Salmonella* sp. *Escherichia coli*, *Staphylococcus aureus, Enterococcus faecalis* and *Bacillus cereus.* Twenty-five grams of each sample was homogenized in 225 ml peptone water (0.1 %) using a stomacher model 400 (Seward Laboratory, London, UK) for 1-2 min to give a final dilution of 1:10. Samples were then serially diluted and plated using the appropriate medium.

Evaluation the efficacy of the jute treatment to repel arthropod pests of cowpea

a.Choice test method:

Source and rearing of the tested arthropods:

Grain mite A. siro: Mites were collected from bran using Tullgren funnels with 2 cm deep muslin layer, at acarology bio-control Lab., National Research Center.

Distinct characteristics were used to identify *Acarus siro.* On the back of A. siro's body there is an incision between the 2nd and 3rd pair of legs. The males of *A. siro* possess tarsal and anal suckers as well as a clearly expressed hook-like extension at the thighs of the first leg pair. The females possess a claw at the end of each foot. Both sexes possess 4 long dragging hairs on the back end [25]. For producing population of *A. siro*, isolated mites were transferred to rearing chambers. Dry Baker's yeast granules were added as food and drops of water as a source of humidity. Cultures were kept at 20 ± 2°C and 60 ± 5% relative humidity. For solitary rearing, newly deposited eggs of well identified females were transferred to plastic blocks of 3×3×0.5 cm (an egg per a block). Each block contained a small rearing circular chamber of 1.2×0.4 cm. The bottom of each chamber was filled with mixture of Plaster of Paris and charcoal.

The plastic block was covered with a rubber band and kept in incubator at 20 ± 2°C and 60 ± 5% relative humidity. After hatching, Baker's yeast and drops of water were daily added. Larvae were kept till reaching adulthood to be used in acaricidal essay of the essential oils.

Cowpea beetles C. maculatus

Rearing of test insects: C. maculatus adults were collected from naturally infested cowpea seeds and reared on uninfected cowpea seeds (*Vigna unguiculata* (L.) Walp), Cowpea seeds (Dokki, 126) maintained on 0.0°C for 7 days to kill any pests. Adult insects, 1–2 days old was used for each test. The insect cultures were maintained in the temperature humidity controlled chamber in darkness at a temp. 25–29°C and 75–85% relative humidity as suggested [26].

To test oviposition deterrent activity of test materials against the cowpea beetle. One circular treated and another untreated from jute fabrics (Cm^2 diameter) were placed in Petri dish (7 cm diameter) in addition to cowpea (5 grains). Two pairs of the cowpea beetle was introduced into Petri dish then closed and stored at ambient conditions for 7 days. After 7 days, the cowpea beetle was removed and their eggs were counted. After 3-5 days, the eggs hatched were counted by binocular microscope.

Also, as the previous test, in relation to the acaricidal activity of tested materials against *Acarus siro* adults, similar Petri dishes were used except that each one has ten individuals of *A. siro* adult female/dish. Three replicate of total 30 individuals/treatment After 3 days, the individuals were counted using stereomicroscope on the cowpea seeds to estimate mortality percentage instead of repellent % carried out with *C. maculates.* The rates of application of treated fabrics were mentioned in the materials and methods.

Oviposation deterrent index was calculated as follows :

$$\text{Oviposation deterrent index} = \frac{C - T}{C + T} . 100$$

where : C = represents the number eggs obtained with control sample

T = represents the number eggs obtained with the treated sample

b.Non-choice test method

This method is similar to the previous one, except every Petri dish contains only one swatch whether treated or untreated. Oviposation deterrent index was calculated as mentioned by equation 1.

Results and Discussion

Swatches from the scoured fabrics were treated separately with chitosan (1 % aqueous solution) (substrate I), chitosan and neem extract (substrate II), triclosan (substrate III) and R-CD followed by neem extract (substrate IV). Treated and untreated fabrics were monitored for antibacterial and insect repellent properties. Results obtained along with appropriate discussion is follows.

Antibacterial properties

Antibacterial activates of the treated and untreated jute fabric were determined against two kinds of bacteria, namely Staphylococcus aureus (*S. aureus*) (as gram-positive bacteria) and *Escherichia coli (E. coli)* (as gram-negative bacteria) according to Agar Diffusion Method (AATCC Test Method 100-2004) [24]. Inhibition zone diameter formed around the test samples were taken as a measure for antimicrobial activity. Results obtained are set out in Table 1.

It is seen from Table 1 that:

(i) Scoured and untreated jute fabrics did not show any antimicrobial properties towards *S. aureus* or *E. coli.*

(ii) All substrates show antimicrobial properties towards *S. aureus* or *E. coli.*

(iii) Different treatments of jute fabrics with chitosan 1% or with chitosan 1% and neem extract 1% enhances its antibacterial activity towards both *S. aureus* and *E. coli* where the inhibition zone increases from 19 to 32 mm for *E. coli* and increases from 21 to 36 for *S. aureus* after treatment with chitosan in the presence of neem extract.

(iv) Triclosan treated Jute fabrics enhances its antibacterial activity towards both *S. aureus* and *E. coli* where the inhibition zone increases to 45 mm for *E. coli* and to 53mm for *S. aureus.*

(v) R-CD treated Jute fabrics enhances its antibacterial activity towards both *S. aureus* and *E. coli* where the inhibition zone increases to 41 mm for *E. coli* and to 47 mm for *S. aureus.*

TABLE 1. Effect of treatment type on the antibacterial properties of jute fabrics.

Substrate No	Treatment	Inhibition zone (mm)	
		E. coli	*St. aureus*
Blank	Scoured	**0.0**	**0.0**
I	Treated with chitosan 1% aqueous solution	**19**	**21**
II	Treated with chitosan 1% aqueous solution and 1% neem extract dissolved in ethyl alcohol	**32**	**36**
III	Triclosan	**45**	**53**
IV	R-CD followed by neem extract	**41**	**47**

Efficacy of jute treatment on the repellence of Cowpea pests

The cowpea (*Vigna unguiculata.* L. Walp) is one of grain crops of high economic and nutritional value. However, under Egyptian environment, drought stage dry pill are exposed to infection by cowpea weevil (*Callosobruchus maculatus)* of various types that during stage of storage causing a loss percentage in the grain in a country like Nigeria from 50-100%, while in Egypt the percentage of loss approaches 52.1%. Also, with storage being bad injury caused by grain or cheese mite *Acarus siro.*

Fig. 1. Grain mite (acarus Siro).

Fig. 2. Cowpea weevil.

The treated jute fabrics were evaluated as insect repellent or insect static package for storing cowpea for different time intervals. Oviposation deterrent index was used as a measure as insect repellent or controlling the population of cowpea weevil or *Acarus siro*. Results obtained are set out in Tables 2-4.

Results obtained in Table 2 show that :

1) Untreated jute fabric did not show any deterrent effect toward *Callosobruchus maculatus*
2) All treatments show a sharp decrement in average number of hatching eggs and average number of adults after 7 days but with different rates.
3) Best results and higher decrement in average number of hatching eggs and adults indicated by using scoured jute treated with a Chitosan in the presence of neem (substrate II) as well as scoured jute treated with R-CD in the presence of neem (substrate IV) both of them has deterrent effect reached to 100 % against *Callosobruchus maculates,* followed by Triclosane treated jute (Substrate III) which has deterrent effect reached to 95.4 %.
4) Jute treated with only Chitosan (Substrats I) has deterrent effect amounted only 40 % against *Callosobruchus maculates.*

TABLE 2. Effect of treatment type of jute fabrics on *Callosobruchus maculatus* adults evaluated using non-choice test.

Non-choice test results displays that the treated jute fabrics has a great efficiency on *Callosobruchus maculatus* adults as shown in Table 2.

Treatment	Treatment conc (g/L)	Non –Choice		
		Avg. No. of Eggs laid[1]	Avg. No. of hatching eggs[2]	Deterrent effects (%)
Blank[3]	0.0	42.0	38.0	0.0
Chitosan *Substrate (I)*	1.0	35.0	22.0	9.1
	2.0	22.0	13.0	30.30
	4.0	18.0	8.0	40.0
Chitosan and Neem extract *Substrate (II)*	5.0+1.0	20.0	11.0	35.50
	10.0+2.0	8.0	0.0	68.0
	15.0+4.0	0.0	0.0	100
Triclosan *Substrate (III)*	5.0	27.0	11.0	21.73
	10.0	15.0	6.0	47.37
	15.0	1.0	0.0	95.34
R-CD and Neem extract *Substrate (IV)*	5.0+1.0	20.0	11.0	35.50
	10.0+2.0	8.0	0.0	68.0
	15.0+4.0	0.0	0.0	100

[1] Average number of eggs laid by 2 adults female after 7 days

[2] Average number of hatching eggs after 7 days

[3] Blank represent scoured untreated jute fabrics

Results of choice method obtained in Tables 3 shows that :

1) Untreated jute fabric did not show any deterrent effect toward *Acarus siro*.
2) All treatments show a sharp decrement in average number of adults after 7 days but with different rates.
3) Best results and higher decrement in average number of adults indicated by using treated scoured jute represented in (substrate II, III and IV) all of them has deterrent effect reached to 100 % against *Acarus siro*.
4) Jute treated with only Chitosan (Substrats I) has deterrent effect reached to 62.50 % against *Callosobruchus maculates*.

Microbial count

A known weight from Egyptian wheat was stored in a package made from treated jute package for one year and the microbial count was monitored every month. In this report, we will present the data obtained after one, three and six months. The package content was monitored for Total anaerobic bacteria count, Total mould count, *Coliform* and *Bacillus cereus*. Results obtained are set out in Table 5 and 6. Results obtained of the treated as well as untreated fabric are set-out in the same table for making comparison.

Results of Table 5 and 6 depict the following:

1) Untreated jute fabric did not show any reduction to microbial infections
2) For those samples treated with 1 % chitosan (substrate I), there is a sharp decrement the total anaerobic bacteria count in bacterial count, Total mould count, *Coliform* and *Bacillus cereus* after one, three and six months.
3) Similar results were obtained with substrates II, III, IV.

TABLE 3. Effect of treatment type on *Callosobruchus maculatus* adults evaluated using choice test method.

Choice test results displays that the treated jute fabrics has a great efficiency on *Callosobruchus maculatus* adults as shown in Table 3.

Treatment	Treatment conc (g/L)	Choice test		
		Avg. No. of Eggs laid[1]	Avg. No. of hatching eggs[2]	Deterrent effects (%)
Chitosan *Substrate (I)*	1.0	22.0	19.0	26.66
Control	0.0	38.0	36.0	
Chitosan *Substrate (I)*	2.0	20.0	18.0	38.46
Control	0.0	45.0	43.0	
Chitosan *Substrate (I)*	4.0	15.0	12.0	47.36
Control	0.0	42.0	38.0	
Chitosan and Neem extract *Substrate (II)*	5.0+1.0	12.0	8.0	60.0
Control	0.0	48.0	42.0	
Chitosan and Neem extract *Substrate (II)*	10.0+2.0	4.0	1.0	82.60
Control	0.0	42.0	40.0	
Chitosan and Neem extract *Substrate (II)*	15.0+4.0	0.0	0.0	100
Control	0.0	38.0	31.0	
Triclosan *Substrate (III)*	5.0	22.0	15.0	15.38
Control	0.0	30.0	26.0	
Triclosan *Substrate (III)*	10.0	15.0	12.0	40.0
Control	0.0	35.0	33.0	
Triclosan *Substrate (III)*	15.0	0.0	0.0	100
Control	0.0	41.0	38.0	
R-CD and Neem extract *Substrate (IV)*	5.0+1.0	12.0	8.0	60.0
Control	0.0	48.0	42.0	
R-CD and Neem extract *Substrate (IV)*	10.0+2.0	4.0	1.0	82.60
Control	0.0	42.0	40.0	
R-CD and Neem extract *Substrate (IV)*	15.0+4.0	0.0	0.0	100
Control	0.0	38.0	31.0	

[1] Average number of eggs laid by 2 adult's female after 7 days

[2] Average number of hatching eggs after 7 days

[3] Blank represent scoured untreated jute fabrics

TABLE 4. Effect of treatment type on *Acarus siro* evaluated using non-choice method.

Non-Choice test results displays that the treated jute fabrics has a great efficiency when evaluated against *Acarus siro* as shown in Table 4

Treatment	Treatment conc (g/L)	Non –Choice	
		Avg. No. of adults[1]	Deterrent effects (%)
Blank [2]	0.0	78.0	0.0
Chitosan *Substrate (I)*	1.0	35.0	38.05
	2.0	22.0	56.0
	4.0	18.0	62.5
Chitosan and Neem extract *Substrate (II)*	5.0+1.0	10.0	77.27
	10.0+2.0	3.0	92.59
	15.0+4.0	0.0	100
Triclosan *Substrate (III)*	5.0	58.0	14.70
	10.0	35.0	38.05
	15.0	0.0	100
R-CD and Neem extract *Substrate (IV)*	5	10.0	77.27
	10	4.0	90.24
	15	0.0	100

[1] Average number of adults after 7 days
[2] Blank represent scoured untreated jute fabrics

TABLE 5. Results of microbial count test on using Egyptian Wheat stored in the treated jute fabrics.

Treatment	Time (Month)	Total anaerobic bacteria count	Total mould count	*Coliform*	*Bacillus cereus*	Total bacterial count
Blank [1]	0	3×10^3	8×10^7	1×10^4	4×10^5	5×10^6
	1	3×10^3	9×10^7	1×10^4	4×10^5	6×10^6
Chitosan *Substrate (I)*	0	3×10^3	8×10^7	1×10^4	4×10^5	5×10^6
	1	1×10^3	4×10^7	6×10^3	2×10^5	4×10^6
Chitosan and Neem extract *Substrate (II)*	0	3×10^3	8×10^7	1×10^4	4×10^5	5×10^6
	1	3×10^3	7×10^7	8×10^3	3×10^5	4×10^6
Triclosan *Substrate (III)*	0	3×10^3	8×10^7	1×10^4	4×10^5	5×10^6
	1	1×10^3	5×10^7	5×10^3	1×10^5	2×10^6
R-CD and Neem extract *Substrate (IV)*	0	3×10^3	8×10^7	1×10^4	4×10^5	5×10^6
	1	2×10^3	6×10^7	7×10^3	2×10^5	3×10^6

[1] Blank represent scoured untreated jute fabrics

Conclusion

New generations of cellulosic-based products (fabrics) functionalized to provide permanent bioactivity for food packaging applications were developed. Swatches from the scoured jute fabrics were treated separately with chitosan (1 % aqueous solution) (substrate I), chitosan and neem extract (substrate II), triclosan (substrate III) and reactive cyclodextrin (R-CD) followed by neem extract (substrate IV). Treated and untreated fabrics were monitored for antibacterial and anti-anthropoids properties. Results obtained showed that, jute fabrics treated with chitosan and neem extract exhibit antibacterial activity towards both *S. aureus* and *E. coli* compared

TABLE 6. Results of microbial count test on using Egyptian Wheat stored in the treated jute fabrics.

Treatment	Time (Month)	Total anaerobic bacteria count	Total mould count	*Coliform*	*Bacillus cereus*	Total bacterial count
Blank [1]	3	3×10^4	8×10^8	1×10^3	4×10^4	5×10^6
	6	3×10^5	9×10^9	1×10^4	4×10^3	6×10^5
Chitosan *Substrate (I)*	3	3×10^2	4×10^5	2×10^3	1×10^4	1×10^4
	6	1×10^2	1×10^4	1×10^2	2×10^3	3×10^3
Chitosan and Neem extract *Substrate (II)*	3	2×10^3	5×10^6	5×10^2	4×10^3	5×10^5
	6	2×10^2	4×10^5	2×10^2	3×10^2	4×10^4
Triclosan *Substrate (III)*	3	1×10^3	3×10^5	1×10^3	4×10^4	3×10^5
	6	3×10^2	5×10^4	2×10^2	3×10^3	4×10^4
R-CD and Neem extract *Substrate (IV)*	3	1×10^3	5×10^6	4×10^3	4×10^4	2×10^5
	6	3×10^2	4×10^5	6×10^2	5×10^3	1×10^4

Blank represent scoured untreated jute fabrics

with the untreated one. Moreover, untreated jute fabric did not shows any deterrent effect toward *Callosobruchus maculates,* whereas all treatments show a sharp decrement in average number of hatching eggs and average number of adults after 7 days of incubation but with different degree. Higher decrement in average number of hatching eggs and adults was observed when jute fabrics treated with a chitosan in the presence of neem (substrate II) and those fabrics treated with R-CD in the presence of neem (substrate IV) were used as packaging for cowpea. The deterrent effect reached to 100 % against *Callosobruchus maculates*.

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استخدام اقمشه الجوت النشطه بيولوجيا فى مجال تعبئه وتخزين الحبوب والبقوليات

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نبذة
تعتبر الحاجة الى اغذية خالية من الميكروبات من اهم الإتجاهات البحثية فى الوقت الحاضر لذا اكتسبت التجهيزات المضاده للميكروبات فى الاونه الاخيره اهميه كبيره من الناحيه العلميه والصناعيه على حد سواء. ونظراً لأهمية مواد التعبئة والتغليف لما لها من دور هام في المحافظة على صفات الجودة للمنتج الغذائي بالإضافة إلى حمايته من التلوث الميكروبي وكذلك منع أو إيقاف النمو الميكروبي بالمنتجات الغذائية نتيجه الاتصال المباشر بين الأقمشة المضادة للميكروبات المستخدمه فى تغليف المواد الغذائية مع المواد الغذائية المحتضنة لمثل هذه الكائنات الحية الدقيقة وهذا من شأنه أن يزيد من العمر الافتراضي للأطعمة ويقلل من خطر الأمراض التي تنتقل عن طريق الأغذية. لذا فان التوصل الى مواد تعبئة و تغليف مضادة للميكروبات او طاردة للحشرات امنة بيئيا يؤدى الى تقليل الفاقد والتالف من المواد الغذائية علاوة على زيادة فترة التخزين الآمن للمواد الغذائية.

تناولت البحوث الحديثة الكثير من أنواع مواد التعبئة والتغليف مثل الورق والبلاستيك والكرتون وما تم إبتكاره من أنواع أخرى سميت بالأغلفة القابلة للأكل والتي تم تحميلها بالمركبات النشطة المضادة للميكروبات سواء مستخلصات نباتية أو زيوت عطرية أو مركباتها الرئيسية المسئولة عن النشاطية المضادة للميكروبات.

الهـــدف
يتمثل الهدف من هذا البحث فى تطوير عبوات التغليف المبنية على المواد السليلوزية باستخدام اقمشة الجوت النشطة بيولوجياً والتى تتميز بأحد الصفات الاتية او مجموعها (عبوات تعبئة وتغليف مضادة للميكروبات, عبوات تعبئة وتغليف لها خاصية طاردة للحشرات).

التجارب المعمليه
تم اجراء التجارب المعمليه من خلال عمل دراسة تهدف الى التوصل الى انسب الطرق التكنولوجية لتحضير هذه العبوات مع دراسة الاقمشة الفيزوكيميائية علاوة على دراسه خواصها البيولوجية ومدى مساهمتها فى رفع معدل الامان للغذاء وزيادة فترة التخزين للحبوب والبقوليات دون ان تتأثر المادة الغذائية.
ومن هنا تم استخدام نسيج الجوت وتمت معالجته للحصول على أربعة معالجات تتمثل فى

- معالجة بالكيتوزان منفرداً (محلول مائي ١٪).
- معالجه بالكيتوزان مع مستخلص نبات النيم.
- معالجه بالترايكلوسان.
- ثم أخيراً معالجه الجوت باستخدام مركب مونوكلوروترايازينيل بيتا سيكلوديكسترين مع مستخلص النيم.
- تم دراسه خواص الأقمشة المعالجة وغير المعالجة وتقيمها كمواد مضاده للبكتيريا ومضادة للميكروبات بالاضافه لتقيمها كمواد طاردة للحشرات.

النتائج
أظهرت النتائج أن اقمشه الجوت المعالجه بالكيتوزان مع مستخلص نبات النيم أعطت أفضل النتائج بالنسبة للتأثير الطارد للحشرات والمقاوم للبكتيريا مقارنه بأقمشه الجوت غير المعالجه, كما اظهرت النتائج ان الاقمشه المعالجه بالكيتوزان وكذلك المعالجه بالكيتوزان فى وجود النيم وكذلك المعالجه بالمونوكلوروترايازينيل فى وجود النيم) هي الأفضل في التأثير المضاد للميكروبات سواء في أطباق الآجار أو أثناء التخزين في العبوات المصنعة من الجوت المعالجة بالمعالجات السالف ذكرها.

تظهر جميع الاقمشه المعالجه انخفاضا حادا في متوسط عدد فقس البيض للحشرات ومتوسط عدد الحشرات البالغه بعد ٧ أيام من الحضانة ولكن بدرجة مختلفة. لوحظ انخفاضا أعلى في متوسط عدد فقس بيض الحشرات والبالغين عندما تم معاملة الأقمشة الجوتية باستخدام الكيتوزان في وجود النيم (المعالجه الثانية) وتم استخدام تلك الأقمشة المعالجة بالمونوكلوروترايازينيل في وجود النيم (المعالج الرابعة) فى تعبئه وتخزين اللوبيا حيث وصل تأثير الردع إلى ١٠٠٪ ضد تكاثر الحشرات.

توصى الدراسه باستخدام اقمشه الجوت المعالجه فى المجالات الصناعيه التطبيقيه وخاصه فى مجال تعبئه وتخزين الحبوب الغذائيه لما لها من خصائص مقاومه للبكتيريا والميكروبات والحشرات بالاضافه لكونها امنه تماما .