DEVELOPMENT AND ABSORBENCY CHARACTERIZATION OF HONEY COATED ALCHITE FIBERS FOR BURN WOUND DRESSINGS

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ABSTRACT**:** *Current research work aims at producing composite Alchite fibers (core material made up of alginate polymer + outer surface made up of hydrolyzed chitosan) through solution spinning method by using Pakistan origin honey and then measuring the absorbency of developed fibers. Nine different sample fibers were prepared. The dope tank concentration containing sodium alginate solution was varied between the limits 3.5 %w/v to 4.5% w/v. While the concentration of hydrolyzed chitosan solution was kept in the range 1% w/v to 2% w/v in the coagulation bath. The produced fibers were subjected to surface coating with small bee honey and 50% aloevera gel + 50% small bee honey by volume mixture. The water absorbency of developed fibers was found in range 14 – 19 g/g while the salt solution absorbency was measured in the range 30-40 g/g of fiber. Both the water absorbency and salt solution absorbency of produced fibers exhibited slight enhancement after coating with honey mixtures. The results indicate that the surface coated alchite fibers are excellent candidate for the production of wound dressings for highly exudating wounds because of their excellent water absorbency and salt solution absorbency. The wound dressings made from these fibers would require two replacements in 24 hours period for normally exudating burn wounds. This is likely to accelerate the wound healing process by absorbing the excess wound exudate and thereby minimizing the possibility of infection. The wound dressings made from these fibers are likely to permit a trauma less replacement as they would keep the wound surface moist attributed to excellent gelling properties of the core material.*

1. INTRODUCTION

Pakistan is a country where more than one million people annually suffer from burn injuries. According to a report by World Health Organization, about 35 % of burnt victims especially children in Pakistan end up in temporary or permanent disabilities. Since the primary cause of improper healing and disabilities is the infection complication attributed to excess wound exudate, therefore, it is need of the hour to develop a material which would minimize the infection complications and to promote faster wound healing when used as a wound dressing [1].

The cotton fibers based wound dressings are not very efficient in minimizing the infection complications as they have a painful replacement process owing to inferior strength of fibers and they also render the wound surface dry because of high water vapor transmission rate. Both these factors contribute to infection complications [2].

Bio polymers based textile wound dressings offer the advantage of covering and protecting the wound from microbial infections as they are highly absorptive, haemostatic, biocompatible, non-toxic and antimicrobial. These bio based wound dressings include alginate dressings, chitosan dressings, hydro gels and high absorption dressings [3].

Alchite fibers developed in this research work are composite fibers with calcium alginate as core material and hydrolyzed chitosan as outer surface. The developed fiber is likely to show excellent absorption properties due to the presence of alginate and honey [4].

In this perspective the produced Alchite fiber have been surface coated with honey and honey-aloevera mixtures to further increase their absorption capacity and thereby enhancing their effectiveness for the treatment of burn injuries which exudate excessively. After successfully conducting the clinical trials of these fibers based dressings, this research work is likely to serve as a milestone for the commercial production of "High Absorption Wound Dressings" in Pakistan.

2. MATERIALS AND METHODS

2.1 Materials

Materials mentioned below have been used in this research work.

2.1.1. Sodium alginate

Sodium Alginate was imported from "Anhui Elite Industrial Co. Ltd China" with zero bacterial count and moisture content<15%.

2.1.2. Chitosan

Chitosan was imported from "Fujain Huankang Biochemical Co. Ltd China" with a degree of deacetylation >60.

2.1.3. Honey

Pakistanis origin natural honey was obtained from local market.

2.1.4. Aloevera gel

Aloevera gel was extracted from freshly cut aloevera plant.

2.1.5. Calcium chloride

Calcium chloride was obtained from "Mazhar International Pakistan"

2.2 EXPERIMENTAL METHODS

2.2.1 Sodium alginate solution preparation

4 % w/v solution of Sodium-Alginate was prepared by dissolving 3.5grams of sodium alginate in 96 grams of water. An electrically driven stirrer was used at 800RPM for 4 hours to well mix the contents. The solution was poured into the dope tank and was left for 24 hours so that any gases evolved may be vented and the fibers do not show extensive breakage during spinning. The same scheme was repeated for the preparation of 4 % w/v and & 4.5 % w/v solutions. These solution concentrations were selected owing to their spinning suitability for the purpose [5].

2.2.2. Hydrolyzed chitosan solution preparation

1% acetic acid solution was used to dissolve 1 gram of chitosan and stirring was continued till the formation of a clear solution. This was followed by the addition of 3.5% HCl solution. The solution was again stirred for 2 hours followed by 4 hours of heating in the reflux bottle. The solution was filtered after cooling overnight and poured into the dope tank. The same procedure was repeated for 1.5% and 2% solution. Current concentration limits were selected due to their wet spinning suitability [5].

2.2.3 Spinning the solution into fibers

The fibers were prepared using wet spinning technique elaborated in fig 1.

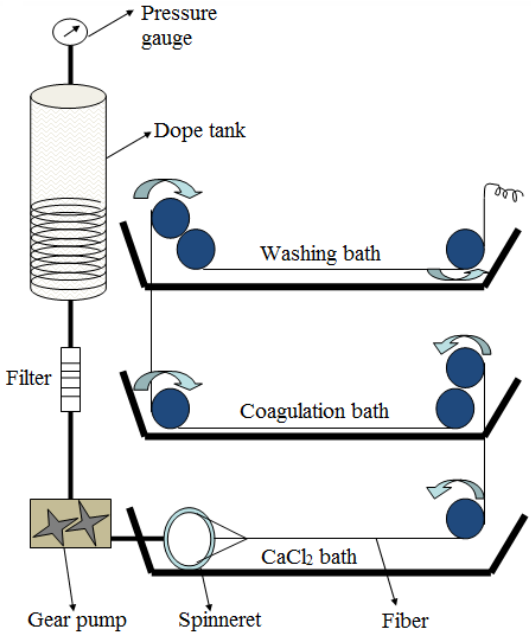

Fig.1 spinning of the solution to form fibers

The dope tank solution was spun into fibers of diameter 0.04 mm by using spinneret with 40 circular holes in it. Nitrogen gas pressure of 5 Psi was applied in the dope tank which forced the solution through the spinneret and fibers were formed. The $CaCl_2$ bath facilitated the exchange of sodium ions with Ca ions. This led to the formation of fibers containing calcium alginate. These calcium alginate fibers interacted with the hydrolyzed chitosan to yield a composite fiber .This composite fiber was washed in the washing bath to remove any unattached material before taking up onto the cone. The same scheme was used for different concentrations of sodium alginate hydrolyzed chitosan solution.

2.2.4 Drying and coating the produced fibers

The prepared fibers were subjected to drying by acetone solution followed by five minutes of drying in the air at aluminum foil. The fibers were then surface coated with small bee honey and with 50 volume % honey-alovera mixture.

2.2.5 Absorbency test of spun fibers

Absorbency was checked in both distilled water and in 0.3 w/v% NaCl solution [5]. Fibers after 100 °C overnight drying were weighed. Their weight was again found after one hour of dipping in water and salt solution. The water absorption was calculated using the simple weight difference before and after dipping.

2.3 Fiber samples prepared

Table 1: Composition and nomenclature of fibers prepared

Sr #	Fiber type	Dope tank concentration (%w/v)	Coagulation bath concentration (%w/v)
1	F1	3.5	1.0
2	F2	4.0	1.0
3	F3	4.5	1.0
4	F4	3.5	1.5
5	F5	4.0	1.5
6	F6	4.5	1.5
7	F7	3.5	2.0
8	F8	4.0	2.0
9	F9	4.5	2.0

3. RESULTS

3.1 water absorbency of uncoated fibers

The water absorbency of developed fibers varied from 14.65 g/g to 19.24 g/g as the dope tank concentration was increased from 3.5 %w/v to 4.5 %w/v and that in the coagulation bath from 1 %w/v to 2 %w/v.

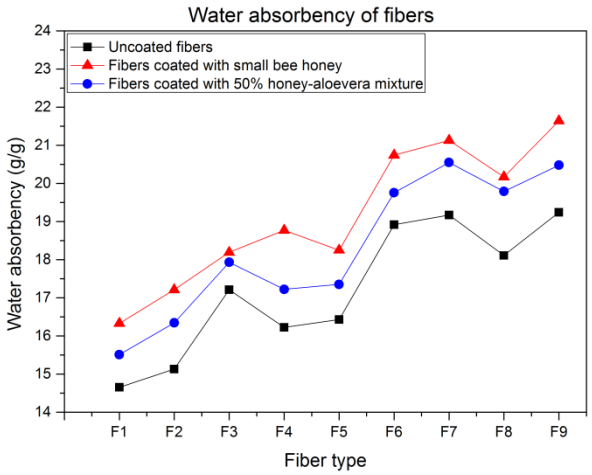

Fig. 2: Water absorbency of fibers

3.2 Water absorbency of fibers coated with small bee honey

As is evident from figure 2, the water absorbency of same fibers when coated with small bee honey was found in the range of 16.33 g/g to 21.64 g/g which is about 10% higher than the absorbency of uncoated fibers.

3.3 Water absorbency of fibers coated with 50% honey-aloevera mixture

As is clear from figure 2, the water absorption of fibers after coating with 50% honey-aloevera mixture showed an increase of about 5% and was found in the range 15.51 g/g to 20.48 g/g.

3.4 sodium chloride solution absorbency of uncoated fibers

As seen from figure 3, the sodium chloride solution absorbency of uncoated fibers was found in the range 29.13 g/g to 40.11 g/g.

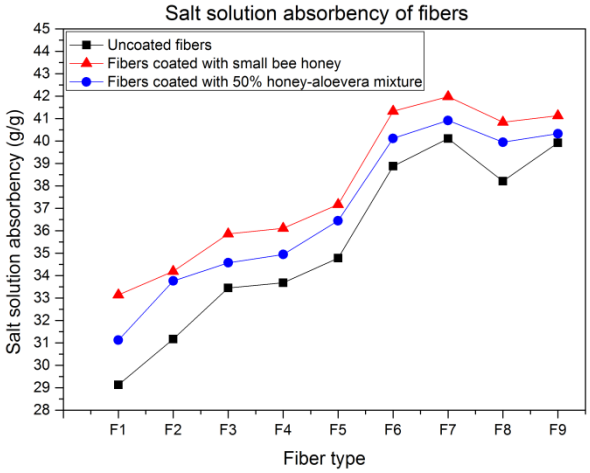

Fig. 3: Salt solution absorbency of fibers

3.5 Sodium chloride solution absorbency of fibers coated with small bee honey

The salt solution absorbency of fibers after coating with small bee honey was in the range 33.14 g/g to 41.98 g/g and it was about 10% higher than the absorbency of uncoated fibers.

3.6 Sodium chloride solution absorbency of fibers coated with 50% honey-aloevera mixture

The salt solution absorbency of fibers after coating with 50% honey-aloevera mixture showed an increase of about 5% and was in the range 31.12 g/g to 40.92 g/g.

3.7 Comparison of water and salt solution absorbency

The sodium chloride solution absorbency of all the developed fibers was found to be double than that of water absorbency. The same trend was observed in case of coated fibers. This fact is indicated in the accompanying figure 4.

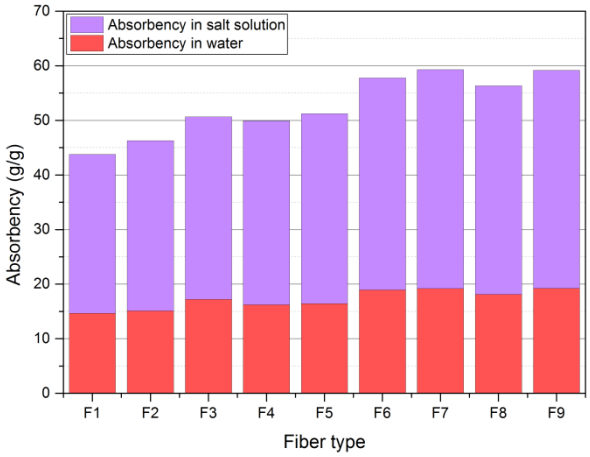

Fig. 4: comparison of water and salt solution absorption of fibers

4. DISCUSSION

The increase in the water absorption of fibers with increase in the alginate and hydrolyzed chitosan solution concentration is attributed to the fact that the alginate possesses excellent gelling properties [6].

The sodium chloride solution absorbency of fibers showed somewhat greater increase due to the ion exchange process between the calcium alginate and sodium chloride solution thereby enhancing the absorption.

The increase in absorption capacity of fibers upon coating is likely to be attributed to the osmolarity of honey which also enhances its antimicrobial activity against infection causing pathogens [7].

5. CONCLUSIONS

On the basis of absorption studies it can be concluded that the developed fibers are potentially excellent to be used in the fabrication of non-woven burn wound dressings due to their higher absorption capacity.

The further increase in the absorption capacity of fibers after coating with honey and honey-aloevera mixture makes them even more suitable for burn wound dressings.

A burn wound dressing made from these fibers will facilitate the wound healing process by minimizing the wound exudate and thereby minimizing the possibility of infection at the wound surface.

6. ACKNOWLEDGEMENTS

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7. AUTHORS' CONTRIBUTIONS

The practical work and manuscript preparation was carried out by Engr. Muzammil Mehmood under the kind guidance of Dr. Rashid Masood and Prof. Dr. Shahid Raza Malik.

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