Journal of Pharmacognosy and Phytochemistry
Available online at www.phytojournal.com

E-ISSN: 2278-4136
P-ISSN: 2349-8234
JPP 2019; SP5: 129-131

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(Special Issue- 5)
International Conference on
"Food Security through Agriculture & Allied Sciences"
(May 27-29, 2019)

Antibacterial finish on silk fabric with pomegranate and onion peel extracts

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Abstract
Silk fabric and garments are susceptible to microbial attack, as these provide large surface area and absorb moisture required for microbial growth. Understanding the importance of use of silk fabric in our day to day life and considering the significance of antibacterial finish on textiles, to overcome consumer health problems faced by the consumers due to environment hazards like microbes, it is of great concerns to use of discarded underutilized peels of fruits and vegetables. So the present study was planned to assess the efficacy of pomegranate and onion peel extracts on cotton fabric with respect to bacterial resistance. Pomegranate and onion peel extract were extracted by Soxhlet method and applied in two concentrations i.e. 3g/l and 5g/l. Degummed silk fabric was finished with these two pure extracts of pomegranate and onion peels and their three standardized combinations by exhaust method. SEM analysis was also done for visual analysis of extract absorbed by the fabric. To study the effect of finished on fabric with pure pomegranate and onion peel extracts and their combinations for bacteria resistance activity, quantitatively by AATCC-100 test method. In study, it was found that as the concentration of extract increased, bacterial reduction of all finished samples also increased. Among all the treatments, silk fabric finished with combination of 50:50 was found to be more in bacterial reduction as compared to combination of 25:75 and 75:25 and pure pomegranate and onion peel extracts. It was 98.06% bacterial reduction in silk fabric with 5g/l concentration in the combination of 50:50.

Keywords: Bacterial resistance, silk, soxhlet, extract

Introduction
Bacterial growth on the textiles can be inhibited by applying the antibacterial finish. Antibacterial finish can be applied with chemical and natural botanical antimicrobial agents. Antimicrobial agents are bacteriostatic and biocidal hence inhibit or kill the microorganisms by damaging the cell wall (Madigan and Martinko, 2006) [5]. Anti-microbial agents like triclosan, quaternary ammonium compound, metal salts solution, antibiotics and nano silvers are available for the use on textiles (Mahesh *et al*., 2011) [6]. Synthetic antimicrobial agents lead to fabric strength loss, make the fabric stiff, change the colour of the fabric and also harmful for the environment (Hussain, 2006).
Demand for healthy life style attracted attention towards antibacterial finishing of textiles. Antimicrobial agents of natural origins have become more popular due to enormous therapeutic potential and effectiveness in the treatment of infectious disease while mitigating the side effect of the synthetic antimicrobials (Tawiah *et al*., 2016) [9]. Antimicrobial textile production has soared over the years, making it one of the fastest growing sectors in the textile industry (Nichifor *et al.*, 2009) [8]. The textile intelligence forecasted that global market for antimicrobial agents for all ends uses, indicating textiles, to grow by nearly 12 percent per annum between 2013 and 2018 (Anson, 2014) [2].
Silk is also natural fibre containing protein having hydrophilicity. It is also susceptible to microbial attack during usage and storage. Clothing made of silk fibers is of great importance to consumers due to their comfort ability, shine, and rich appearances and being ever green fashion fabrics. In order to retain the nature of such textiles as well as for proper care, antimicrobial treatment or finishing is necessary.
Textile industry, continuously searches for new technologies in order to accomplish the consumers' demands.

Recently new developments allowed the production of functional and smart textiles which are capable of sensing changes in environmental conditions or body functions and responding to these changes. Likewise, consumers' attitude towards hygiene and active life style has created a rapidly increasing market for a wide range of textile products finished with antimicrobial properties, which in turn has stimulated intensive research and development. There is a measureless resource of natural antimicrobial peptides which can be exploited for imparting antimicrobial properties to textile substrates. The main advantage of antimicrobial substance is that they are small molecules that can be impregnated or covalently bound to textiles in a very effective and homogenous deposition.

Materials and Methods

Pure silk fabric and two underutilized peels each from the exhaustive lists of fruits and vegetables i.e. pomegranate and onion were selected on the basis of survey and collected from the Hisar market. Use of these selected underutilized peels of pomegranate and onion for the preparation of extracts by soxhlet method. Exhaust method was used for the application of two pure extracts of pomegranate and onion peel and their standardized combinations i.e. 50:50, 25:75 and 75:25 on the degummed silk fabric in two concentrations i.e. 3g/l and 5g/l. The surface morphological structure and characteristic of all finished and controlled samples of silk fabric were analyzed by Scanning Electron Microscope (Philips XL 30) with an accelerating voltage of 10 kv for magnification. To study the effect of finished silk samples with pure pomegranate and onion peel extracts and their combinations for bacteria resistance activity, quantitatively by AATCC-100 test method.

Result and Discussion

1. Determination of yield percentage of pomegranate and onion peel extracts

The results it was found that the yield percent of pomegranate and onion peel extracts were obtained by soxhlet method from air dried powder of the peels for 8 hours was 17.27% and 7.46% respectively and showed in Table 1. Thus, yield percentage of pomegranate peel extract was found to be higher as compared to yield percentage of onion peel extracts. The air dried powder weight of the onion peel was less as compared to air dried powder weight of pomegranate peel. The difference in the yield percentage of extract may due to the variation of chemical composition and also due to the difference in the physical and chemical properties such as solubility of compound present in the peel of the pomegranate and onion.

Table 1: Determination of yield percentage of pomegranate and onion peel extract

Underutilized peels	Weight of air dry powder (g)	Method of extraction	Time period of extraction (hours)	Weight of the extract (g)	Percentage yield
Pomegranate Peel	134	Soxhlet	8	23.14	17.27
Onion Peel	134	Soxhlet	8	10	7.46

2. Scanning electron microscopic (SEM) analysis of finished and controlled fabrics

The surface morphological structure of controlled (unfinished) and finished samples of silk fabrics were analyzed by Scanning Electron Microscope (Philips XL 30) and are showed in the plate 1. It was showed that unfinished silk fabric depicted the smooth surface of fiber with striation while slight deposition of extracts of pomegranate and onion peel on the surface of finished silk fabric. Surface morphology features of the silk fabric finished with combinations extract of pomegranate and onion peel were analyzed and these were showed in plate1. It was found that silk fabric finished with 50:50, 25:75 and 75:25 combinations showed more granules on the surface of fabric, as compared to unfinished fabric and fabrics finished with pure pomegranate and onion peel extracts.

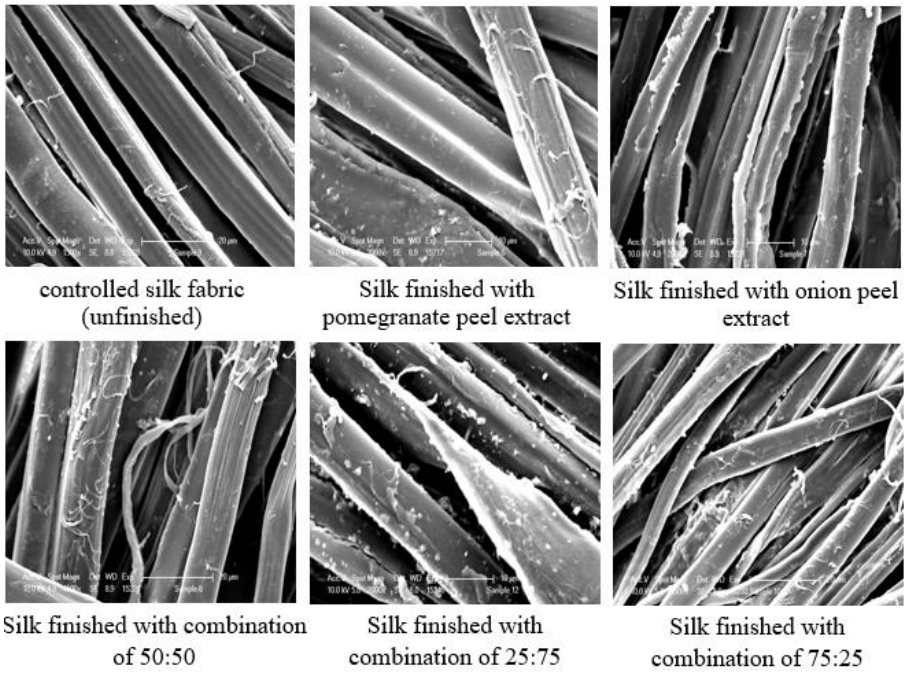

Fig 1: SEM of control and finished fabric with pomegranate and onion peel extracts

3. Determination of bacterial resistance of the finished fabrics

To determine the bacterial resistance of the fabrics finished with pomegranate and onion peel extracts and their combinations in two different concentrations i.e. 3 g/l and 5 g/l by exhaust method, the growth of *E. coli* bacteria was counted quantitatively by AATCC-100 test method. The efficacy of pomegranate and onion peel extracts and their combinations was compared against the control sample and also among themselves. Bacterial reduction of finished silk fabric are given in Table 2**.** It is evident from the data that there was confluent lawn of growth of bacteria on the control sample. After finishing the silk fabric by exhaust method with 3 g/l and 5 g/l concentrations of pomegranate peel extracts separately, percent reduction value were 96.06% and 96.61%, respectively. When onion peel extract was applied by exhaust method with 3 g/l and 5 g/l concentrations, the percentage reduction values were 95.48% and 95.97%, respectively.

Data also depicted the bacterial reduction against various combinations of pomegranate and onion peel extracts. It was found that 50:50 combination of pomegranate and onion peel extract exhibited maximum bacterial reduction i.e. 97.74% with 3 g/l concentration using exhaust method followed by 75:25 and 25:75 combinations with 97.26% and 96.77% bacterial reduction respectively. With 5 g/l concentration of the same extract i.e. pomegranate and onion peel extracts, the bacterial reduction value increase to 98.06%, 97.42% and 96.93% using 50:50, 75:25 and 25:75 standardized combinations on silk fabric. Results of the study are also supported with Al Laham *et al.* (2014) [1] and Mahajan *et al.* (2014) [7] who studied antimicrobial activity of various parts of *Punica granatum* against antibiotics resistance *E. coli*, *S. aureus*, *Shigella flexneri* and *Candida albicans* and found that a combination of promising antibacterial extracts has exerted synergistic effect against *E. coli.*

On comparing the efficacy of all silk finished samples among themselves and with control sample, with pure extracts of pomegranate and onion peel, their combinations, different concentrations and application methods, it can be concluded that silk fabrics finished with different combinations of pomegranate and onion peel extracts i.e. 50:50, 25:75 and 75:25 showed better efficacy against bacterial growth as compared to pure pomegranate and onion peel extracts in both concentrations and application methods. Bakarnga *et al*., (2016) [3] also stated that extracts from different parts might be used in combination to achieve improved antibacterial potency.

The efficacy of 50:50 combination of pomegranate and onion peel extracts was maximum whereas efficacy of the extract in 75:25 combination i.e. with three by fourth amount of pomegranate was higher than that of 25:75 combination having one by fourth of the pomegranate and three by fourth amount of onion peel extract. Further the efficacy of pure pomegranate peel extract in all treatments against bacterial reduction was determined higher than pure onion peel extract. As the concentration of pure extracts and their standardized combinations increased, bacterial reduction also increased.

Table 2: Determination of bacterial reduction of silk fabric finished with pomegranate and onion peel extracts by quantitative method

Application Methods	Conc. of extracts (g/l)	Bacterial count (CFU/ml) (% Reduction) (*E. coli*)				
		Pomegranate peel extract	Onion peel extract	Combinations of pomegranate and onion peel extracts		
				(50:50)	(25:75)	(75:25)
Exhaust Method	3	2.4 x 10^6 (96.06%)	2.8 x 10^6 (95.48%)	1.4 x 10^6 (97.74%)	2.0 x 10^6 (96.77%)	1.7 x 10^6 (97.26%)
	5	2.1 x 10^6 (96.61%)	2.5 x 10^6 (95.97%)	1.2 x 10^6 (98.06%)	1.9 x 10^6 (96.93%)	1.6 x 10^6 (97.42%)
Control (unfinished)	Confluent growth					

It can concluded that the yield percentage of pomegranate peel extract was found to be higher as compared to yield percentage of onion peel extract and it can also be concluded that silk fabric finished with different combinations of pomegranate and onion peel extracts *i.e.* 50:50, 25:75 and 75:25 showed better efficacy against bacterial growth as compared to pure pomegranate and onion peel extracts in both concentration in exhaust methods. As the concentration of pure extracts and their standardized combinations increased, bacterial reduction also increased.

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