Original Research Article

Diffusion of Nigelle Sativa oil encapsulated and impregnated in textile structure

ABSTRACT

The high-performance textiles are mentioned not new but they have evolved through many years of scientific research. This has resulted in many new inventions and creative innovations making textile industry one of the most important industries in the world.
Textiles can act as delivery systems of bioactive compounds as they are in contact with the skin. Hence, they are now widely used for medical, hygienic, health, and cosmetic purposes. Medical textiles are becoming an increasingly important area in technical textiles. They can provide a controlled slow release of the active medical ingredients to be absorbed through the skin. Cosmetotextiles are the textiles, which are embedded with cosmetic ingredients that have to be transferred to the wearer's skin, and the amounts transferred have to be sufficient to ensure that cosmetic benefits are possible. There are opportunities for health and well-being by using cosmetotextiles in which substances that enhance skin appearance, or vitamins can be absorbed by the skin.
Textiles have been used for protection from solar radiations since the time of ancient civilizations. Textile structures render unique characteristics required for the sun screening apparel such as pliability, good mechanical strength, softness, esthetics, and other engineered properties. However, textiles as such may not be able to provide effective protection and it should be treated with ultraviolet (UV) blocking agents to ensure that the fabrics deflect the harmful UV rays. Several UV blocking agents are being developed to add or to improve the UV protection function of the textiles.

Keywords: high-performance textiles, Medical textile, Health care, Human values, Cosmetotextiles, Anti UV textile

1. INTRODUCTION

At the moment, Healthcare design is interested in the problems related to the health of the man and the quality of their life. It examine care environment that can not only prevent injuries, but also provide psychological support to facilitate the healing process. In addition, it is a multidisciplinary and humanistic process that uses different specialties such as, designers (products, textiles, space ...), researchers and administrators of institutions such as (hospitals, associations, laboratories, etc. and who need to combine their strengths and skills to assess the effects of innovation in product design. "Recent advances have begun to change perceptions for new ways of preventing disease, extending life and improving health and well-being.

Indeed, thanks to technological advances, textile design is ubiquitous in the current preoccupations of people who have specific requirements like diseases to design new fabrics and new innovative and creative methods. The aim of this article is the diffusion of Nigella Sativa oil encapsulated and the impregnated in textile structure for the children of the moon.

2. STATE OF THE ART

Biofunctional textiles are materials that expert a biological effect on human skin. When the textile come into contact with skin, such textile constitutes actives substances incorporate into the fabrics, which may break when a garment rubs the skin. This technology merges the univers of cosmetics and textiles through the process of microencapsulation. This last is a technique of cosmetotextiles [1].

Currently, there are textile in the market claim to be moisturizing, body slimming, energizing, refreshing, relaxing and UV protection. Microencapsulation technology can be used in case of essential oils, therapeutic smells and drugs. There are many different methods to fix the microcapsules onto textile fibers and surface. The technology used to add some encapsulated products widely applied in technical, biomedical, sportswear and protection fields.

Microcapsules can be applied to any textile support (fabric, knitwear, non-woven, clothing made) regardless of the chemical nature of the fibers, by conventional finishing techniques or incorporated into the fiber during the spinning stage. They are also sometimes applied during a rinsing cycle of a washing machine. However, the incorporation of microcapsules into any textile substrate can only be achieved by controlling the physico-chemical characteristics of the particles to optimize their compatibility with other compounds in the formulation according to the final application. The choice of the process is based on both efficiency and durability criteria for microcapsules. Thus, for specific uses in the clothing sector, microcapsules must have a wash life of at least 20 cycles, with thermal stability allowing ironing or tumble drying. During washing, the chemical action of alkaline products, friction and temperature can alter the microcapsules.

Children must wear long clothing, covering all parts of the body, gloves, closed shoes, wide-brimmed hats and sunglasses with sufficient UV-filtering glasses with wide side frames are essential.

2.1 Smart end uses of textile substrates containing microcapsules (Drug realize textile)

Fabrics containing microcapsules can be considered the latest generation of smart textiles, because new properties are brought to bear as well as added value. A smart textile is one that can provide a specific function to the wearer through the direct contact of a textile material to transfer active substances to the human body or skin. Microencapsulated materials are commercially available from many companies [2] for various areas of application to offer potential for use in smart textiles. Microencapsulation technology for smart textile coatings

199 Applications include the use of PCMs and cooling agents for comfort; delivery systems for cosmeto-textiles (including fragrance release, aromatherapy agents, skin moisturising or skin cooling agents, controlled release of vitamins or other agents absorbed through the skin), antimicrobials, biocides and insect repellent and resist treatments, fire-retardant compounds, dyes and pigments, thermochromic, or photochromic agents for dyeing and printing, sizing and bonding agents, blowing and expanding agents and additives for washing textiles (detergents, fabric softeners, enzymes, bleaching agents) [3]. In addition, microcapsules can be used as biosensors and anticounterfeiting agents.

2.2 Performance in textiles

When Materials of Changed Phase Microcapsules (mPCMs) are applied to a textile substrate, they can absorb heat energy from the body or from the environment, to go from a solid to a liquid state, and then create a temporary cooling effect in the clothing layer until the completed melting of the core material. The reversibility of this effect can be obtained when the smart textile is worn in an environment, where the temperature is below the crystallization point of the PCM formulation.

Therefore, this kind of textiles can react as an active thermal barrier effect to regulate heat flux through the structure and adapt the heat flux to thermal needs according to the activity level or ambient temperature changes [4].

Because the sensation of thermal comfort refers to the state of mind that expresses satisfaction with the thermal environment, this feeling is influenced by various parameters in which the garment design has an important role. Thus, the use of mPCMs in clothing should act in addition to the passive thermal insulation effect of the garment system. To design a specific clothing layer, the quantity of mPCMs should be adjusted with regard to the activity level and duration of the garment worn, bearing in mind maintaining sufficient breathability, flexibility and mechanical stability of the structure. Thus, to obtain the desired effect, the manufacturer should pay attention to selecting an appropriate PCMs formulation to determine the sufficient quantity of the PCMs, choosing the appropriate fibrous substrate and designing the product [5]. The magnitude and duration of thermal effect depend on design textile factors.

2.3 Protection: flame retardant

Coating with microencapsulated flame retardant

For a coating process, the wetted microencapsulated flame retardants are dispersed throughout a polymeric binder, a surfactant, a dispersant, an antifoam agent and a thickener. All of the common coating processes, such as knife-over-roll, screen printing, pad-dry-cure, knife-over-air and gravure and dip coating should be used. The method for the composition of manufacturing a coating containing microcapsules has been widely described in the patent literature; nevertheless few articles published in the literature have given an account of the formulation of coating, finishing of fabrics and therefore the evaluation of their characteristics, especially the thermal and durability properties. From the 2000s onwards, Giraud et al. demonstrated the FR effect of ammonium phosphate microcapsules on cotton fabric coated with PU and polyurea binders [6]. Vroman et al. evaluated the flame-retardant properties of polypropylene fabrics with three types of microcapsules containing DAHP(diammonium hydrogen phosphate) and with various polymeric shells: ie, polyvinyl alcoholeurethaneeurea, melamineeformaldehyde and melamineepoly(n-hexyl methacrylate)-formaldehyde [7].

2.4 Aromatherapy

Aromatherapy can be considered a form of alternative medicine that uses volatile compounds such as essential oils. Fragrance from the capsule is released only during the 206 Active Coatings for Smart Textiles application of pressure onto the fabric and acts as a healing substance. This type of healing with the help of fragrances using essential oils has been found to have an effect on feelings, moods and emotions. To make aromatherapy easier, textiles can be chosen as a medium. The end-use product includes ribbons, handkerchiefs, curtains and furnishings. To ensure a pharmaceutical effect, the microcapsules should contain fragrance compounds and essential oils without omitting ingredients. Furthermore, to avoid degradation during manufacturing, a low-temperature binder is required to fix the perfumed microcapsules to the textile's surface. Durability in laundering and a soft handle should be also carefully considered [8]. There are a myriad of essential oils with many applications, such as peppermint, which may provide clear thinking, or lavender, which is used to help people relax, as well as valerian or amber oil [9]. To respond to consumer demand, research and development are mainly focused on opportunities and limits for cosmetic and wellness applications of textiles, on possible ways of incorporating active substances in a functional manner with increased durability, on the characterisation model for assessing cosmetic textiles for safety and on biological safety and benefits to human skin [10].

2.5 Insect repellent

Insect repellent compounds used in textile finishes are either synthetic chemicals such as DEET (N,N-diethyl-3-methylbenzamide), picaridin (1-piperidinecarboxylic acid 2- [2-hydroxyethyl]-1-methlypropylester) or permethrin, or natural products (essential oils) such as citronella, neem, lemon and eucalyptus. Insect repellent agents have been investigated but only a few have been applied to textile materials [11]. Application of these compounds without being entrapped by the impregnation method leads to poor wash fastness. Thus most of them have been microencapsulated by sodium alginate [12] (Anitha et al., 2011), melamineeformaldehyde [3] and silica [13] , before being applied by pad-dry-cure to improve longevity and controlled release of the core substance. Thus, N'Guessan et al. showed that the microencapsulation of DEET inhibits blood feeding and kills mosquitoes for at least 6 months under laboratory conditions. This formulation can find application in nets against pyrethroid-resistant mosquitoes or on clothing or bedding materials distributed in disasters, emergencies or refugee camp situations [14]. Textiles treated with microcapsules containing citronella developed by Miro Specos et al. have higher and longer-lasting protection from insects compared with fabrics sprayed with an ethanol solution of citronella oil, and ensure a repellent effect higher than 90% for 3 weeks. The repellent textiles were developed by padding cotton fabrics with microcapsule slurries using the conventional pad-dry method [15]. Microencapsulated lemongrass oil extract was studied by Anitha et al. for its repellence abilities and compared with extract-finished fabrics. Their results showed 92% repellence activity for polyester fabric finished with lemongrass aqueous extract microcapsules. Polyester fabric exhibited only 80% mosquito-repellent activity when it was finished with methanolic microcapsules of lemongrass leaves. Lemongrass oil Microencapsulation technology for smart textile coatings is capable of repelling mosquitoes on fabric to a greater extent. This study concluded that lemongrass oil extract exhibits significant irritant and repellent properties and deserves further investigation for possible use as active ingredients in topical skin and indoor dispersed repellent systems [12].

Results showed that inventive textiles finished after 25 machine washes contained more than 80% of the originally applied insect repellent whereas the content of unencapsulated insect repellent under the same conditions fell to below 40% [16]. In this invention, the active ingredient may be released by skin pressure and friction. The patent filed by Syngenta Ltd. concerns a treated textile fabric with a microencapsulated insecticide and a polymeric binder [17]. The coated or partially coated fabric maintains a sufficient amount of microencapsulated insecticide on the fabric surface to kill or repel insects, particularly mosquitoes, even after repeated washings. The fabric can be made into a net or a garment for protection against insect-transmitted diseases such as malaria.

3. MATERIALS AND METHODS

The aim of this current study is to prepare and investigate ethylcellulose microcapsules, containing Nigelle Sativa oil into knitted cotton fabrics using the phase separation method. Ethylcellulose is hydrophibic polymeric coating material can be used for extended drug release.

3.1 Materials

Nigelle sativa oil usually employed as a natural remedly to hydrate and protecte the skin against different diseases.

The exceptional properties of cotton in relation to moisture management make the fabric more confortable to wear when contact with the skin.

Acrylic Resin (AR) was used as binder in order to make sure the microcapsules adherence onto the textile support. The prepared microcapsules alone and fixed onto compressive knit were then analyzed by Scanning Electron Microscopy (SEM).

Cotton, polyester were purchased from EL ZARDA (Tunisia). Ethylcellulose (EC N100) was purchased from Hercules (USA). Ethyl acetate, analytical regent grade, was purchased from Scharlau (Spain). Nigelle sativa oil, pharmaceutical reagent grade, was purchased from Parastore(Tunisia). Sodium lauryl sulfate was purchased from Sigma-Aldrich (Germany).

3.2 Methods

Microencapsulation Efficiency

The encapsulation efficiency corresponds to the percentage of the active ingredient encapsulated compared with the total quantity of active ingredient used initially to prepare the microcapsules. Encapsulation efficiency (E (%)) was calculated according to equation (1):

(1) where E(%) is the encapsulation efficiency, EMJO is the mass of encapsulated nigella sativa oil, TMJO is the total mass of nigelle sativa oil used for the assay; MEC-JO is the microcapsules mass before ultrasonication and MEC is the microcapsules mass after oil extraction.

Nigelle sativa Oil Content Determination

Nigelle sativa oil content determination in ethylcellulose microcapsules has been done as follows : An amount of 200 mg of ethylcellulose microcapsules, accurately weighed, were pouring into 10 ml of cyclohexane and then ultrasonicated for 1 min to extract nigelle sativa oil. After ultrasonication, samples were filtred using a 0.45 µm filter and then the microcapsules were dried at 30 °C for 2 h in the aim to eliminate the residual solvent (cyclohexane). Nigelle sativa oil content (JOC) was determined from the mass differences of microcapsules containing nigelle sativa oil (MEC-JO) and capsules after oil extraction (MEC) according to equation (2):

(2) where MEC-JO is the microcapsules mass before ultrasonication, MEC is the microcapsules mass after oil extraction and JOC is the nigelle sativa oil content. The experiments were repeated 10 times and the results were expressed in percent [18].

Preparation of Ethylcellulose Microcapsules

Ethylcellulose microcapsules were prepared as reported in the literature:

Phase A: ethylcellulose (300 mg) was dissolved in ethyl acetate (5 ml) under continuous stirring (1500 rpm). Then, 700 mg of jojoba oil were added to this solution. The stirring was maintained, after that, for 15 min. Phase B: sodium lauryl sulfate (500 mg) was dissolved in water (50 ml). 6 ml of ethyl acetate was added to this aqueous solution under a continuous stirring (1500 rpm). Next, phase A was dropped into phase B. 100 ml of water were added to the formed emulsion to extract the organic solvent. The formed microcapsules were isolated by filtration, washed five times with distilled water and dried at 40 °C for 12 h.

Fig. 1. Preparation of microcapsules

(a) The oily phase: 0.3 g of ethylcellulose (EC-N100 NF) and 5 ml of ethyl acetate, put in a 25 ml beaker at a magnetic stirring of 1000 rpm. Nigella oil is added with continuous magnetic stirring.

(b) The aqueous phase: 0.5 g of sodium lauryl sulphate and 50 ml of water placed in a 100 ml beaker subjected to magnetic stirring at 1000 rpm. 6 ml of ethyl acetate are added with continuous magnetic stirring.

(c) The oily phase is then added to the aqueous phase little by little with magnetic stirring at a speed of 1000 rpm. An emulsion is obtained. The emulsion is placed in 100 ml of water under magnetic stirring at 1000 rpm for 1 hour. Ethylcellulose forms the separating layer of the microcapsules that enclose the product.

(d) The phase is rested

(e) The microcapsules are separated using vacuum pump, a 0.45 micron filter paper.

(f) Drying

4. RESULTS AND DISCUSSIONS

4.1 Sieving

This technique is widespread and inexpensive. We separated the different sizes obtained by microencapsulation process by sieves. Below 80 microns, the classification of the particles becomes random by this technique

4.2 Imaging analysis

Imagery can visualize objects in two dimensions, and the analysis of images can appreciate not only the size but also the shape of the particles.

Microcapsules must be characterized in order to link their properties to their performance. The characterization concerns:

Size

There are different granulometric techniques to determine the size of microparticles

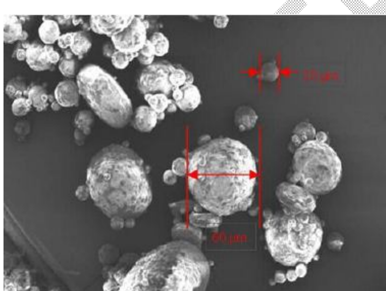

Fig. 2. Microscopic observation (SEM) of the microcapsules of the oil (300 x)

This study can be used for all types of microencapsulation in oil for example oil nigella. A microscopic observation using a scanning electron microscope makes it possible to determine the average size of the microcapsules obtained. The figure shows that the average size of the microcapsules of oil is of the order of 40 microns. Several factors influence the size of these microparticles, for example, the stirring speed during formation of the microcapsules, the higher the speed, the smaller the average size. The figure shows a fairly large variation in the size of the microcapsules. This variation in size helps a difference in the release time of the active ingredient that is requested; since the mechanical behaviors of microcapsules whose size is relatively large are not identical to those of small size

4.3 Microscopic appearance

Microscopy techniques make it possible to determine the shape of the particles, their sizes, their homogeneities as well as their densities. The shape of the microcapsules observed by a scanning electron microscope is generally spherical in the figure below

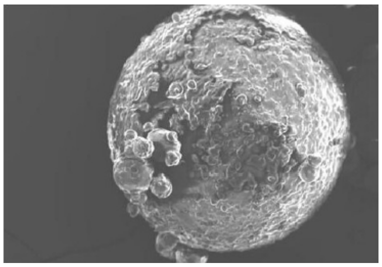

Fig. 3. Microscopic observation of the structure of the microcapsule surface (1000 x)

4.4 Effects de Nigelle sativa in dermatology

N.sativa have wide range of pharmacological effects; immune-stimulatory, anti-inflammatory, hypoglycemic, antihypertensive, antiasthmatic, antimicrobial, antiparasitic, antioxidant and anticancer effects [19].

Fig. 4. Nigelle sativa plant

Our case study is the children of the moon (Xeroderma Pigmentosum) are a rare autosomal recessive disease characterized by increased sensitivity to UV and sunlight. Without full and effective protection of sunlight, patients suffer accelerated aging of the skin, burns, and pigmentation disorders and inevitably develop eye and skin lesions that can lead to multiple cancers.

Fig. 5. Frontal image of face, showing large hyperkeratotic lesions with some induration suspicious of actinic keratosis and early squamous cell carcinoma.

Fig. 6. This left lateral view of the face shows the diffuse nature of the hyperpigmented lentigos on the face and neck.

Xeroderma Pigmentosum affects both men and women worldwide, and its prevalence (number of people affected in a given population at a given time) ranges from 1 to 4 cases per 1,000,000 in Europe and the United 1 case for 40 to 100,000 births in Japan, the Maghreb countries and the Middle East. Xeroderma pigmentosum is a rare orphan disease in the world, relatively common in North Africa and some Middle Eastern countries in relation to high inbreeding [20].

In fact, XP is a group of diseases, with eight different genes (located on different chromosomes) that, when mutated, result in XP. There are seven classic XP groups (from A to G, see Table 1) and one for XP variant (occurring in adulthood). It is often difficult to distinguish between the different types just based on the symptoms, but there are still some differences depending on the mutated gene (especially symptom severity and age of onset). The type C, called "classical", is the most frequent in France

4.5 Protection against lesions, preventive treatments

The XP treatment imposes a report on sun and UV exposures. This is to avoid maximum exposure to the sun all day long. Therapeutic patient education plays an important role in protecting all body surfaces from UV radiation. Among the practices used by these children, wearing protective clothing, sunscreens, UV-absorbing glasses, and a long haircut. Some patients wear custom hats that absorb UV.

Fig. 7. types of protection UV

Photoprotection is the first measure introduced to prevent precancerous and cancerous lesions.

Photoprotection must be ideal, including a Photoprotection clothing and places of life (habitat, car, school, work, etc.) and care, completed by sunscreen products. In addition, artificial light sources (UV) must be tested using a dosimeter and then each window in homes, classrooms in schools ... must be filtered by anti-UV.

Children must wear long clothing, covering all parts of the body, gloves, closed shoes, wide-brimmed hats and sunglasses with sufficient UV-filtering glasses with wide side frames are essential.

5. CONCLUSION

The actors of the cosmetotextile sector are constantly innovating, always designing more products for beauty and well-being. The new regulations being put in place will better meet consumers' expectations and guarantee the quality and effectiveness of the products offered on the market. Microencapsulation as an area for research has great potential for development, particularly in environmentally friendly formulations according to the choice of the active.

Microencapsulation technology for smart textile coatings ingredients to be coated, the structure of polymer membrane, method of textile finishing for fixing the particles and the functionalisation of the supports. Moreover, the potential applications of microencapsulation in the textile field are as important as the imagination of researchers and the industry, the fact remains that the major issues are the evolution of legislation in terms of the toxicity of the products used, the biocompatibility of the raw materials of textile finishing systems in response to environmental stimuli (smart membranes), the extension of encapsulation methods for water-soluble active coating and the integration of these functional coatings (microcapsule textiles) in other application areas. Thus, future work will focus not only on microcapsules but also on the textile processes. Therefore, exploiting the potential of microencapsulation through research, process control, and the combination and adaptation of different technologies, research in textile industry must continue to open up other sectors to develop the textiles of the future desired by consumers.

REFERENCES

1. Blas, H., Ferreira, I., Cosmétotextiles, journal of chemicalnews,2012,https://www.lactualitechimi-que.org/Les-cosmetotextiles, 42/45.

2. Van Parys, M., 2006. Smart textiles using microencapsulation technology. In: Ghosh, S.K. (Ed.), Functional Coatings. Wiley-VCH Verlag GmbH & Co. KGaA, pp. 221/258.

3. Boh, B., Knez, E., 2006. Microencapsulation of essential and phase change material for applications in textile products. Indian Journal of Fibre & Textile Research 31, 72/82.

4. Pause, B.H., 2001. Interactive Thermal Insulating System Having a Layer Treated with a Coating of Energy Absorbing Phase Change Material Adjacent a Layer of Fibers Containing Energy Absorbing Phase Change Material. US Patent 6217993.

5. Bendrowska, W., 2006. Intelligent textiles with PCMs. In: Mattila, I. (Ed.), Intelligent Textiles and Clothing. Woodhead Publishing in Textiles, Cambridge, England, pp. 34/62.

6. Giraud, S., Bourbigot, S., Rochery, M., Vroman, I., Tighzert, L., Delobel, R., 2001. Flame behavior of cotton coated with polyurethane containing microencapsulated flame retardant agent. Journal of Industrial Textiles 31 (1), 11/26.

7. Vroman, I., Giraud, S., Salaun, F., Bourbigot, S., 2010. Polypropylene fabrics padded with microencapsulated ammonium phosphate: effect of the shell structure on the thermal stability and fire performance. Polymer Degradation and Stability 95 (9), 1716/1720.

8. Nelson, G., 2001. Microencapsulation in textile finishing. Review of Progress in Coloration and Related Topics 31 (1), 57/64.

9. Wang, C.X., Chen, S.L., 2005. Aromachology and its application in the textile field. Fibres & Textiles in Eastern Europe 13 (6), 41/44.

10. Cheng, S.Y., Yuen, M.C., Kan, C.W., Cheuk, K.K., Chui, C.H., Lam, K.H., 2009. Cosmetic textiles with biological benefits: gelatin microcapsules containing vitamin c. International Journal of Molecular Medicine 24, 411/419.

11. Inceboz, T., Erkan, G., T€urkoglu, G.C., Sarııs¸ık, A.M., Bakırcı, S., €Uner, S., €Uner, A., 2015. In-vivo and in-vitro tick repellent properties of cotton fabric. Textile Research Journal 85 (19), 2071/2082.

12. Anitha, R., Ramachandran, T., Rajendran, R., Mahalakshmi, M., 2011. Microencapsulation of lemon grass oil for mosquito repellent finishes in polyester textiles. Elixir Bio Physics 40, 5196/5200.

13. Chan, A.S.C., del Valle, J., Lao, K., Malapit, C., Chua, M., So, R.C., 2009. Evaluation of silica sol-gel microcapsule for the controlled release of insect repellent, n,n-diethyl- 2 methoxybenzamide, on cotton. Philippine Journal of Science 138 (1), 13/21.

14. N'Guessan, R., Knols, B.G.J., Pennetier, C., Rowland, M., 2008. Deet microencapsulation: a slow-release formulation enhancing the residual efficacy of bed nets against malaria vectors. Transactions of the Royal Society of Tropical Medicine and Hygiene 102 (3), 259/262.

15. Specos, M.M., Garcia, J.J., Tornesello, J., Marino, P., Vecchia, M.D., Tesoriero, M.V., Hermida, L.G., 2010. Microencapsulated citronella oil for mosquito repellent finishing of cotton textiles. Transactions of the Royal Society of Tropical Medicine and Hygiene 104 (10), 653/658.

16. Paya, J.G., Aracil, M.A.B., Aboy, P.M.R., Perez, P.M., 2010. Insect Repellent Textile. US 20100183690 A1.

17. Barnett, D., Silverthorne Lesley, A., 2007. Insecticidal Textile Material. WO 2007036710 A2.

18. JAAFAR, F., LASSOUED, M A., SAHNOUN M., SFAR, S., CHEIKHROUHOU, M., 2011. Impregnation of Ethylcellulose Microcapsules Containing Jojoba Oil onto Compressive Knits Developed for High Burns, Fibers and Polymers, Vol.13, No.3, 346-351.

19. Salih.H.M. Aljabre, O.M. Alakloby, M.A. Randhawa, Dermatological effects of Nigella sativa,Journal of Dermatology & Dermatologic Surger(2015)doi:http://dx.doi.org/10.1016/j.jdds.2015.04.002.

20. TAÏEB, A., Care of a child with xeroderma pigmentosum, Chu bordeaux,2012, 4/ 15.