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Biotechnology

Colouring of Wool by Natural Dyes

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Study of ethnobotanical traditions in Georgia revealed that the use of natural products, including plants, in dyestuff has a centuries-old history. Until the second half of the 19th century, only natural raw materials were used to dye wool, i.e. dyes were made from plants, insects, and mollusks. It is true that from the last century, because of the development of chemistry, synthetic dyes were obtained; however, in the dyeing of carpets, rugs, etc. are mainly used natural dyes. Moreover, this process gradually becomes irreversible, as the use of natural dyes eliminates the accompanying diseases that occur when using synthetic materials. Therefore, it is necessary to describe the mechanisms of this process and the plants that have been used in Georgia for centuries. Natural dyes are pigments found in plants and are usually harmless. The effect of their use will not be worse than chemical paint, but the quality can be much higher. Natural dye ingredients are an ecological alternative to synthetic dyes. Pigments obtained from natural dried and fresh grasses, fruits, leaves, stems and plant bark can obtain almost any desired color and tonality. The dyed fabric looks very original and eye-catching. It is soft, with clear colors and sometimes gives the product effect of some antiquity, a special charm of vintage material, the main thing, as we mentioned, such products do not cause allergies and are completely safe for the environment and do not contain artificial impurities. The goal of our research was to find out and analyze the richest ethno-botanical skills of Georgia to use dyes of vegetable origin that are safe for health, which contributes to the development and sustainable use of this direction. *© 2023 Bull. Georg. Natl. Acad. Sci.*

ethnobotanical traditions, pigment, natural dyes

Materials and Methods

Plant material. The use of natural products, including plants, in dyestuff has a centuries-old history in Georgia. Until the second half of the 19th century, only natural raw materials were used to dye wool, i.e. dyes were made from plants, insects, and mollusks. For example, blue dye was obtained from *Isatis*, red dye from *Rubia tinctorum*, brown dye from *Origanum*, black dye from *Haematoxylum campechianum*, and violet dye from lichens. Murex mollusks were made into a very valuable burgundy dye, also known as Imperial dye

[1]. It is true that from the last century, as a result of the development of chemistry, synthetic dyes were obtained, however, in the dyeing of carpets, rugs, etc. are mainly used natural dyes. Moreover, this process gradually becomes irreversible, as the use of natural dyes eliminates the accompanying diseases that occur when using synthetic materials. Therefore, it is necessary to describe the mechanisms of this process and plants that have been used in Georgia for centuries.

Certainly, in today's large-scale production conditions, fabrics are made in factories and offer a plethora of quality garments and professional designs. However, for those who love handicrafts and appreciate natural items, it will be very interesting to paint the product with their own hands in a family setting. All the more, so today handmade items are much more valuable than those made in a conveyor pattern [2, 3].

Ethnobotanical traditions - Skills of dyeing cloth, which our ancestors perfectly mastered, originated in ancient countries in the East and then spread throughout the world. The mastery of the old dyestuff made it possible to obtain more than eight hundred tons of the color spectrum based on just a few dozen natural dyes. The secret of the diversity of the color palette was the interaction of the dyes with different metal salts (varnishes). The process of dying (procedure) was kept secret by the craftsmen and the unique craft traditions were passed down from generation to generation [3, 4].

With the development of textile production and the advent of chemical dyes, the unique process of natural dyeing has gradually disappeared from the practice of textile processing, and many recipes have been lost or forgotten.

Pre-fabric preparation for dyeing. Due to the nature of the material and the processing, different color effects are obtained during the dyeing. The most intense and lasting colors are obtained on pre-prepared fabrics. To do this, soak the fabric in water, then place it in a large pot, 2/3 full of water, where the fabric moves freely. Add baking soda (1 tablespoon of baking soda to 5 liters of hot water). Add a few drops of dish soap, and boil for 15 minutes. Then stir from time to time until the liquid has cooled. Leave overnight. Then rinse well and soak the cloth in acetic acid (1 liter of acetic acid in 4 liters of water) and leave for 24 hours. The fabric should then be thoroughly washed and dried. Such prepared material is ready for quality dyeing, you can start dyeing.

The goal of our research was to find out and analyze the richest ethno-botanical skills of Georgia to use dyes of vegetable origin that are safe for health, which contributes to the development and sustainable use of this direction.

Results and Discussion

Getting natural dyes. To get the dye you need to grind the plant's raw material and boil it in water (some sources recommend using rain or distilled water) over low heat until it gets a rich color in the broth. The resulting solution should be squeezed and the fabric could be dyed. The longer fabric stays in the dye, the richer and clearer the color will be.

Special fixatives of chemical or natural origin are used to fix the obtained color and dye pigment. Also, to better preserve the color, you can boil the material in a saline solution before dyeing or soak acetic acid in aluminum salt for one day.

Getting colors. Let us consider some ways to get the color right.

Beige and cream color. These colors are usually needed to remove or soften the "jaundice". White fabrics often turn yellow over time, which is uncomfortable. Coffee or tea can be used to relieve jaundice.

When using coffee you will need most quickly instant coffee. According to reviews, Jacobs and Nescafe give the best results. They contain a lot of pigment, so dyeing will happen very quickly. It

should be noted that the result obtained is stable, and the color does not change after washing, which is why many use this affordable method. But concentration is important. Depending on the amount of coffee in the solution, the color tone will be different. It is best to pre-select the proportions and try on unnecessary pieces of white fabric.

Tea also contains coloring pigments. For this, you will need tea with a very good brewing ability and high concentration. Such tea should dissolve all the pigments directly in the water, so, for example, disposable packaging packs will not work to get the desired result.

Yellow. Birch leaves (Betula) are often used to obtain yellow pigment. A surprisingly bright and rich tonality is obtained. Acceptable yellow color can also be in pastel tones, for which the roots and bark of the barberry (Berberis) bush give a good effect. *Frangula* bark also gives good results. Moreover, depending on its humidity, the color will be also different. Raw gives a beautiful yellow tone, stable and long-lasting. Dried creates a tone closer to brown.

Artemisia absinthium gives a beautiful straw color, but most often it is mixed with alum (bitter salt), resulting in a lemon color.

Berries are used to get the blue color. Cranberries (*Vaccinium*) and blackberries (*Rubus fruticosus*) can be used to dye the fabric at home for a long period of time. They have a very strong natural pigment that is hard to get rid of even by hand. Get a beautiful, fresh color that is quite suitable for youth clothing. But there are difficulties as well. It is almost impossible to achieve a uniform texture, because somewhere more juice will fall, somewhere less, and the color will be darker or lighter tones, and even further washing will not correct this.

You can also add black currant (*Ribes nigrum*), in which case you can take the grass Ivan and Mariam (Maryannik Dubravny). Their natural colors fit the fabric very well. The flowers are juicy and easily give pigment. At high concentrations, the color will turn deep blue.

Ordinary Brilliant Green also gives good results. It is greenish at high concentrations and takes on a bluish tint, when diluted. Such paints are weak and do not give a strong, lasting color. But you might get a bluish color.

Green. The fruit of juniper (*Juniperus*) is perfect for coloring tissues. But, unlike other berries, getting the pigment is not easy. More concentration is required as the concentration increases. Only in this way is it possible to get a luxurious color [5, 6].

Herbs are an affordable and easy way to get pigment. Parsley (*Petroselinum*), spinach (*Spinacia*), sorrel (*Rumex acetosa*), and coriander (*Coriandrum sativum*) contain a lot of rich pigment that is easily transferred to the tissue. But you have to be careful here because spinach and sorrel contain acid that can damage the thread.

Red. How to get the color red? Any red berries are perfect for dyeing. But, if you do not use strawberries or raspberries (because of the high cost), it is better to take *Sambucus*.

The *Sambucus* pigment is much stronger than other berries and the price is low. Its pigment gives a clear and saturated color.

The skin of the onion (*Allium*) (as in Easter eggs) stains the fabric with a reddish-brown tone. At the same time, it gives a uniform structure and is valued for color fastness. The color cannot be washed off and the item will remain red-brown forever. Greek walnut husk is also used to make red-brown.

The pigment obtained from walnut (*Juglans regia*) husk is characterized by great stability, the product never changes color. The resulting color tones can range from reddish-brown to dark brown, depending on the concentration of pigment in the broth and the dyeing time.

Orange. There is virtually no plant pigment of orange origin and *Hippophae rhamnoides* is practically the only option to get it. Instead, this pigment gives a very dazzling color, penetrates

very deeply into the fiber structure, and practically does not wash off. The color thus obtained is durable and does not fade. It is also possible to adjust the color intensity. Adding lemon (*Citrus limon*) and orange peels (*Citrus sinensis*) slightly softens the tone. Together they reduce the intensity of the coloration. You can also dye the fabric only celery, but the color will be faintly expressed [7, 8].

In most cases, black was always obtained by double dyeing. For example, the material was taken from *Origanum* and the dyeing stuff. Coloring in the *Origanum* was called “Dedeba”. Beautiful brown tones are obtained by dyeing the *Origanum*, this color is very popular in Tusheti, however, it should be noted that in our experiments the tones often changed depending on the pigments, the latter on the parameters of the ecosystem.

We conducted a series of experiments with the participation of M. Lobzhanidze, and materials and recipes for ethnobotanical skills of plants` used in the dyeing were found. Unique plants were selected from them – Origanum, Barberry, and Walnut husk. It should be noted that the dyed material is characterized by a pleasant coloring.

Different colors. Modern. In addition to the standard colors, it is quite possible to make others more interesting and unusual, for example mustard color has very nice and soft tone. But must not be taken mustard powder because it has no dyeing properties. With this, it is quite possible to get it with turmeric. It is important to choose the right concentration so that the color is not pale but not too sharp.

The marble color also looks interesting. To do this, the wool is strongly folded and so placed in a small bowl of paint. The pigment penetrates differently in the folds, from which a characteristic marbled texture emerges.

The eco-print technique or contact dyeing. Recently, an amazing method of putting natural texture and printing plants on fabric is gaining popularity. Elegant scarves, napkins, tunics, dresses, and jackets are painted in an eco-style with a magical structure. There are several ways to add natural ornaments. The easiest way to use an eco-print is to "hammer" the texture of the plant leaves and flowers on the fabric. The selected item is placed on the fabric, covered with parchment paper, and beaten with a hammer until the plant shape, texture, and colors are absorbed into the textile.

"Hot" eco print. The flower leaves, twigs, and petals are spread on a cloth, rolled up, and insisted on low heat or placed under a hot steam press. Natural dyeing is a wonderful way to decorate clothes, to refresh an original old item.

Conclusion

Thus, we can point out that although modern production and technologies provide numerous opportunities for dyeing wool and textiles, use of natural dyes does not lose its relevance. At the same time, many "brand" manufacturers, on the contrary, switched to using natural ingredients and fulfilling individual orders. Against the backdrop of the global environmental crisis, use of natural ingredients has become prestigious. Thus in a family setting, we may quite get the fabric we want and generally attractive, even from an already obsolete item.

ბიოტექნოლოგია

მატყლის ღებვა ბუნებრივი საღებავებით

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**სამცხე-ჯავახეთის სახელმწიფო უნივერსიტეტი, ინჟინერიის, აგრარულ და საბუნებისმეტყველო მეცნიერებათა ფაკულტეტი, ახალციხე, საქართველო
§საქართველოს ტექნიკური უნივერსიტეტი, ბიოტექნოლოგიის ცენტრი, თბილისი, საქართველო

(წარმოდგენილია აკადემიის წევრის თ. სადუნიშვილის მიერ)

საქართველოში ნატურალური, მათ შორის, მცენარეთა საშუალებების გამოყენებას სამღებრო საქმეში მრავალსაუკუნოვანი ისტორია აქვს. მე-19 საუკუნის მეორე ნახევრამდე მატყლის შესაღებად მხოლოდ ბუნებრივ ნედლეულს იყენებდნენ, ანუ, საღებავებს მცენარეების, მწერებისა და მოლუსკებისგან ამზადებდნენ. მართალია, გასული საუკუნიდან, ქიმიის განვითარების შედეგად, მიღებულ იქნა სინთეზური საღებავები, თუმცა ხალიჩების, ნოხების, ფარდაგებისა და სხვ. ღებვისას, ძირითადად, ბუნებრივი საღებავები გამოიყენება. უფრო მეტიც, ეს პროცესი თანდათან შეუქცევადი ხდება, რადგან ნატურალური საღებავების გამოყენება გამორიცხავს თანმდევ დაავადებებს, რასაც ადგილი აქვს სინთეზური მასალის გამოყენებისას. ამიტომ, ამ პროცესის მექანიზმებისა და იმ მცენარეთა აღწერა – გამოკვლევა, რომელთაც საუკუნეების განმავლობაში მიმართავდნენ საქართველოში, საჭირო საქმეა. რა არის ბუნებრივი საღებავები? ეს არის პიგმენტი, რომელიც გვხვდება მცენარეებში და, ჩვეულებრივ, უვნებელია. მათი გამოყენების ეფექტი არ იქნება ქიმიურ საღებავზე უარესი, მაგრამ ხარისხი შეიძლება იყოს ბევრად უფრო მაღალი. ბუნებრივი საღებავების ინგრედიენტები სინთეზური საღებავების ეკოლოგიური ალტერნატივაა. ბუნებრივი გამხმარი და ახალი ბალახის, ხილის, ფოთლების, ღეროებისა და მცენარეების ქერქისაგან მიღებული პიგმენტებით შესაძლებელია თითქმის ნებისმიერი სასურველი ფერის და ტონალობის მიღება. შეღებილი მასალა ძალიან ორიგინალურად და თვალწარმტაცად გამოიყურება. იგი რბილია, მკაფიო ფერებით და ზოგჯერ პროდუქტს რაღაც სიძველის, განსაკუთრებული ხიბლის ეფექტსაც აძლევს, რაც მთავარია, როგორც აღვნიშნეთ, ასეთი პროდუქტები სრულიად უსაფრთხოა ეკოლოგიურად და არ შეიცავს ხელოვნურ მინარევებს. ჩვენი კვლევის მიზანს შეადგენდა საქართველოში არსებული უმდიდრესი ეთნო-ბოტანიკური უნარ-ჩვევების მოძიებით და გაანალიზებით გამოგვეყენებინა ჯანმრთელობისათვის უსაფრთხო მცენარეული წარმოშობის საღებავები, რაც ხელს შეუწყობს ამ მიმართულების განვითარებას და მდგრად გამოყენებას.

REFERENCES

1. Shengelia Z. (1958) Some dye plants of Georgia, 203 p. Tbilisi (in Georgian).
2. Kacharava T. (2020) Biodiversity of medicinal, aromatic, dye, melliferous, spicy and poisonous plants in Georgia, 462 p. ISBN 978-9941-26-728-4; UDC 633.88.+615.322, K-367; Pub. House "Universali", Tbilisi (in Georgian).
3. Ghlighvashvili V. (2008) Processing of wool dyeing of goatling and lamb in home conditions. *Materials of the Georgian Agrarian University*, **I**, 2 (43):114-117. Tbilisi.
4. Ghlighvashvili V., Marmariani I. et al. (2009) Processing wool in home conditions. p. 59-62, State Agrarian University of Armenia.
5. Korakhashvili A., Kacharava T. (2018) Catalog of medicine and aromatic plants of Georgia, 79 p. ISBN 978-5-93728-090-9, Moscow.
6. Kacharava T., Lobzhanidze M. (2019) Useful plants' diversity in Georgia. Advances and perspectives of biodiversity research and conservation in Georgia. *Proceedings of the 1st International Scientific Conference,* p. 50-52. ISBN 978-9941-8-1337-5; Tbilisi, Georgia.
7. Shengelia Z. (1958) Some dye plants of Georgia. 203 p. Tbilisi (in Georgian).
8. Shetekauri Sh. (2013) Atlas of nature of Georgia – plants and animals, 152 p. Publisher Bakur Sulakauri, ISBN 9789941158599, Tbilisi (in Georgian).

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