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Madder (*Rubia tinctorum* L.) as an Economic Factor Under Sustainability Goals in the Textile Dyeing

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ABSTRACT

This study emphasizes that madder is an input compatible with sustainability goals in the textile sector. Madder is an input (dyestuff) that can be used instead of hazardous chemicals in textile dyeing. With this feature, madder has a high trade potential. It has been cultivated and traded throughout history. Although it came to the point of disappearance after the discovery of synthetic dyes, it has gained significance again today. The study aimed to support, the commercial value of madder with figures. In this study, the commercial value of madder emphasized with figures. Madder is a driving force that carries economies from rural development to national development and it is a material compatible with sustainability goals. It has been frequently preferred in textile coloring in recent years because it supports zero discharge of hazardous chemicals. At the empirical stage of the study, the amount of fabric to be dyed with a unit of madder was calculated by multiplying the product obtained per hectare with the dyestuff ratio. Then, the average of the prices of madder obtained from various producers was collected and the commercial value of the madder was revealed. With the understanding of the commercial value of it, countries, producers and all stakeholders with environmental awareness will evaluate the potential.

摘要

本研究强调, 靛子是一种与纺织行业可持续发展目标兼容的投入。茜草是一种输入物(染料), 可用于纺织染色中代替有害化学品。有了这一特点, 茜草具有很高的贸易潜力。它在历史上一直被种植和交易。虽然在发现合成染料后, 它已经到了消失的地步, 但今天它又有了意义。这项研究旨在用数字支持茜草的商业价值。在本研究中, 用数字强调了茜草的商业价值。靛子是推动经济从农村发展走向国家发展的动力, 也是与可持续发展目标相一致的材料。近年来, 它一直是纺织品染色的首选, 因为它支持危险化学品的零排放。在研究的实验阶段, 用每公顷的产品乘以染料比例, 计算出用一单位茜草染色的织物数量。然后, 收集了从各个生产商处获得的茜草价格的平均值, 并揭示了茜草的商业价值。了解其商业价值后, 各国、生产者和所有具有环保意识的利益相关者将评估其潜力。

KEYWORDS

Sustainability; madder; sustainable development; ZDHC; commercial value; foreign trade

关键词

持续性; 靛子; 可持续发展; ZDHC; 商业价值; 对外贸易

Introduction

Madder is a perennial shrub that grows throughout the summer. The upper parts of the plant die in the winter, and in the spring new twigs appear from the twig roots. The plant can grow up to about one and a half meters (Karadag and Dolen 2007). The yield obtained from the roots of a three-year-old madder plant is 3–5 tons per hectare, while the dyestuff is in the range of 150–200 kilograms madder plant is a rich amount of dye plant.

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Almost every region of Turkey is suitable for madder cultivation. The plant grows in shady and wet places. In particular, the plant likes creek beds and chalky-clay, clayey sandy, humus-rich soils (Kayabasi and Dellal 2004). Madder pertains to the “Rubiaceae” family and is a herb that gives color (Cuoco et al. 2009). Madder roots have been used for the production of red color in the dyeing of textiles since 1500 BC. The dyestuffs used for red colors in the historical process are anthraquinones (Baghalian, Maghsodi, and Naghavi 2010). Madder was not used only for dyeing textile but also as a natural lake pigment, for food, cosmetics, pharmaceutical, and medicine. Madder pigments in ancient paintings have been identified as aluminum cations and anthraquinone complexes (Sanyova and Reisse 2006).

The roots of madder are the natural basis of biological colorant and have been utilized to color textiles in most regions of the world from prehistoric times (Derksen et al. 2004).

In this sense, it can be said that madder extract extracted from the dried roots of *Rubia tinctorum* has had usage for dyeing textiles from ancient times. Examples of these regions are India, the Middle East, and Europe. In this regard, madder is also known as traditional herbal medicine Madder pertains to the “Rubiaceae” family and is a herb that gives color. It can be said that numerous anthraquinones have been determined in madder so far (Baghalian, Maghsodi, and Naghavi 2010).

The contents and amounts of anthraquinone compounds of madder vary with the age of the plant (Ferreira et al. 2004). The dyestuffs of *Rubia tinctorum* are anthraquinone dyes. One of the main dyestuffs is alizarin. These roots have been used for the production of red color in the dyeing of textiles since early years (Baghalian, Maghsodi, and Naghavi 2010).

Madder as an economic factor

In the world

When both the distant and recent past is examined, madder is used in the coloring of products such as textiles (carpet, fabric, kilim, etc.) which have been one of the important elements of the production processes. It has contributed indirectly to the development of geographies where it is suitable for cultivation due to its herbal origin (Vilar 1958).

Until the end of the 19th century, the Netherlands was the largest supplier of madder, which is the most popular in natural red color. Looking back to the previous centuries, as early as the 14th and 15th centuries, the province of Zeeland and neighboring regions of the provinces of South Holland and Brabant became important producers (Schot et al. 1992).

In the 17th century, it is seen that the mentioned regions managed to obtain monopoly power in the production of madder. However, it is understood from the records that this monopoly power began to break with the industrialization processes of France in the 19th century (Schot et al. 1992).

Entirely and Tarku, the trade routes passing through Idil-Caspian Trade Road and Dagestan in the 17th century, are included in historical documents as two important madder export centers (Bulbul 2011).

In the chronological process in Europe, madder has become an important item in tax and customs revenues over time. Madder which began to be grown widely throughout Germany was exported in considerable quantities from Magdeburg to Poland, Flanders, Italy, and England (Koc 2009).

When examined from a cultural perspective, it is known that colors were used as status symbols in the past centuries. For this reason, the demand for certain colors has been higher. For example, in Iran and India, red dyes were used not only for a vegetable but also of animal origin. Such madders were produced and exported locally as well as imported and were accepted as luxury goods (Sanyova and Reisse 2006).

Another symbol of social status is the purple color. The best famous purple color is known as Roma purple and the color was obtained from snail (*murex*) in ancient times. Other purple colors were obtained from insect dyes and indigo. Insect dye and indigo were used together for dyeings for purple colors. Another purple color dyeing is the one obtained from madder. The purple color was obtained by two different methods with madder. One of them was obtained from madder and indigo. The other was obtained with madder and iron mordant. In general, the purple dyeing was with madder and iron

mordant method in the wool carpets and kilims. Madder is one of the important plants from which purple color is obtained. The color obtained as Tyros purple by making various mixtures is frequently used in wool and leather coloring (Adiguzel and Kolanci 2017).

In Anatolia, the Ottoman empire and the republic of Turkey

When we examine the journey of madder in the Ottoman Period and the Republic of Turkey from a historical perspective, the production and use of madder are frequently encountered due to the suitable climate. Madder has been one of the indispensable raw materials of leather and other industrial branches. (Kilic 2018)

Madder, buckthorn, and saffron were among the most demanded products in the Ottoman Empire (Yigit and Yucedag 2020). The city of Izmir (Smyrna) has been one of the principle mercantile city since the early stages of the capitalization process of the World economic system.

In the early stages of the capitalization process of the world economic system, the city of Izmir was in an important location in terms of international trade. In the 18th century, products such as carpets of Western Anatolian origin, raw cotton, fruit, and madder were the most important products exported from İzmir (Kerimoglu 2013).

In the 1700s, the Ottoman Empire met two-thirds of the world's madder needs, and until 1875, the revenue of madder only in Izmir exceeded 500,000 gold liras. However, the great transformation toward industrialization in the world economy has encouraged the use of chemical products instead of natural products (Kilic 2018).

When evaluated in terms of the island of Cyprus in the 18th century, it has been noted that the most basic economic activity especially in Famagusta, was root dyeing/madder dyer. It is stated in historical documents that the production of the plant from which madder is obtained is concentrated around the Famagusta castle. Especially the red type of buckthorn was considered very valuable for coloring both cotton fabrics and leather products. In that century, 318 acres of land were planted for the production of madder.

When it comes to the Republican period, one of the most important development moves of the Turkish economy was the Izmir Economy Congress, which was held in 1923. An exhibition was also organized within the congress and products considered prestigious for the domestic economy were exhibited at the exhibition. One of these products was madder.

Madder is an ingredient used in the manufacture of carpets and rugs which derives its colors from various plant and animal sources. One of the vibrant red color sources among these colors is madder (*Rubia tinctorum* L.) also known as Turkey Red (Sanli and Gok 2017).

In many parts of Anatolia, it is typical to encounter plants from which madder is obtained. Unless it is too wet or dry, plants that can provide madder can grow in almost any soil (Baykara and Burrows 1964).

The aforementioned source plants were produced in high quantities not only today or in the 1920s when the Izmir Economic Congress was held, but also in the following provinces in the Ottoman Empire at the end of the 19th century. Mentioned cities: Malatya, Siirt, Maras, Diyarbakir, Beirut, Akkâ, Cebel-i Lebanon, Damascus, Tripoli, Ankara, Kayseri, Cankiri (which was known as Kangiri at that time), Konya, Isparta, Burdur, Teke District of Antalya, Niğde, Teaz, Hudeyde sanjaks, Tripoli, Biga district of Balikesir, Kutahya, İzmir, Saruhan district of Manisa, Zile district of Tokat and Amasya (Baykara and Burrows 1964).

Considering its historical journey, the importance of madder for the Turkish economy is clear. Thus, it will be understood more clearly why it is mentioned as one of the “prestige” products of the industry of the young republic at the Izmir Economics Congress, which is one of the stops of the chronological journey of madder (TOBB 2017).

The official project of madder, which has a history of thousands of years in Turkish Culture, has been with the Natural Dye Research and Development project, which started in 1981 and whose short name is DOBAG. The Project was launched to promote the Turkish carpet and rug tradition and was initiated by the Faculty of Fine Arts of Marmara University (Aytac 2019).

From rural development to national development . . .

Today, although the coloring of products such as textiles and carpets has surrendered to chemicalization, the return to organic and natural colorants is rapidly becoming widespread. Such products are often the subject of rural production. Regional products come to the fore not only with their natural features but also with the fact that they trigger development in the economies of many countries. Especially in European economies, regional products such as madder have a high economic value and are considered to be one of the driving factors of rural development (Joose 2016).

Figures

In this section, the importance of madder in Turkey and the World's foreign trade will be analyzed with statistics. The data for the evaluation specific to Turkey were obtained by using the code 320,300,109,000 with the customs tariff statistical position HS12 which includes madder. However, data regarding the world trade of madder could not be obtained in international sources for further classifications than 6-digit codes.

Therefore, in this part of the study, the evaluations for madder's world foreign trade were made using the data of the "Color matter of vegetable or animal origin product" classification coded 320,300 (6-Digit).

Madder trade of Turkey with figures

According to TUIK (Turkish Statistical Institute) data (TUIK), Turkey's madder export and import figures for the years 2013–2021 were given in [Figure 1](#).

Madder trade in the world with figures

The most actual data on the world madder trade belongs to 2019 ([Table 1](#)). Coloring matter of vegetable or animal origin is the world's 1633rd most traded product.

In 2018 the average tariff for Coloring matter of vegetable or animal origin was 3.63%, making it the 5331st lowest tariff using the HS6 product classification. It is shown in [Figure 1](#)

Sustainability and reducing chemical footprint in coloring

ZDHC (zero discharge of hazardous chemicals)

The concept of sustainable development, which adopts the principle of raising a high consciousness in people, has been on the agenda for many years. Therefore it is important to better understand the conceptual foundations of sustainable development and raise awareness. In this sense, instead of the "development with the environment" approach, the "despite environmental development" approach should be adopted (Karabicak and Ozdemir 2015).

With the Brundtland Report published in 1987 and the Rio Earth Summit held in 1992, the importance of the concept of sustainability came to the fore. It was emphasized that it is necessary to act with a development idea that includes not only the present but also the future and future generations.

A sustainable development action plan including the titles of "Rio Declaration" and "Agenda 21" signed at the Rio Earth Summit and 27 basic principles were signed by the member states of the United Nations (UN).

Under the title of Agenda 21, issues such as the protection and management of natural resources, the change in consumption patterns, environmentally sound biotechnology management, environmentally sound management of toxic chemicals, and environmentally compatible management of hazardous wastes were brought to the agenda (UN).

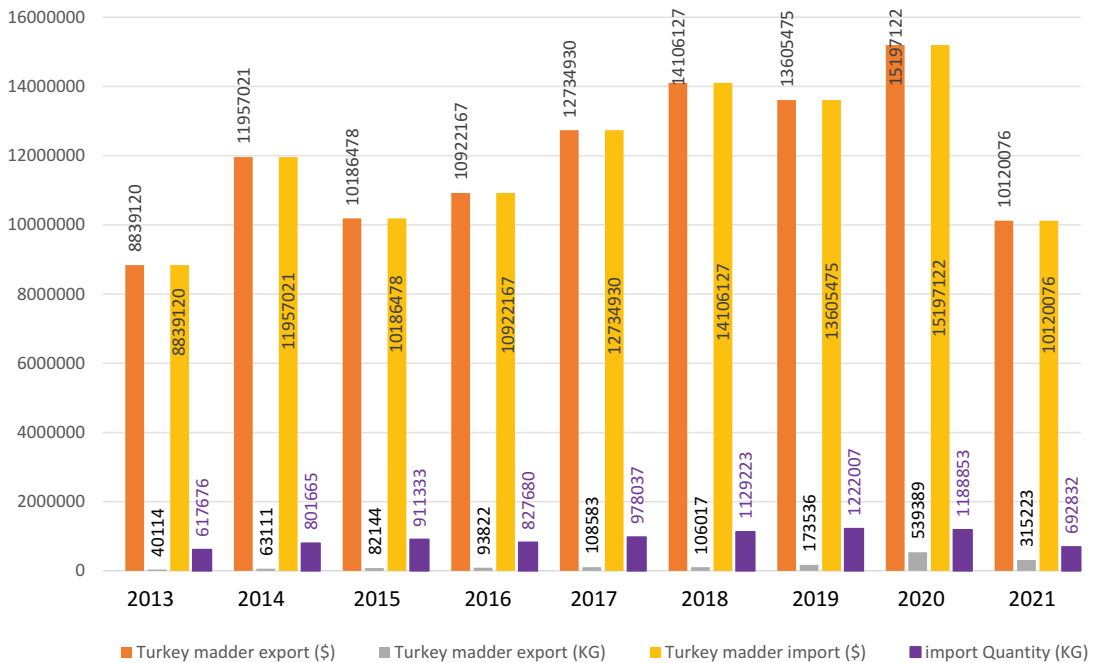


Figure 1. Export-import figures of madder in Turkey.

At this point, it is necessary to mention the concept of ZDHC (zero discharge of hazardous chemicals) in the context of sustainability. One of the largest industries in the world is the textile industry with an approximate value of \$1.3. Employs more than 300 million people in the global value chain (ZDHC-MRSL Industry Standard Implementation)

The role of the textile industry in the development of developing countries is undeniable. The low-cost advantages provided by these countries have also caused the sector to move toward those regions (Nimkar 2018).

From an environmental and social perspective, it seems that the textile industry has a long way to go to become better and more beneficial to the economy. Today, there is 7 kg of textile and apparel consumption per capita, which means more than 49 billion kg of textile products per year. Considering that the world population is increasing exponentially, the damages caused by textile chemicals that will increase soon will reach incredible dimensions (ZDHC-MRSL-Principles and Procedures).

The current textile industry is a highly resource-intensive industry and has turned into a situation that undesirably increases greenhouse gas emissions, excessive water consumption, and the discharge of hundreds of hazardous chemicals (Strategic Approach to International Chemicals Management SAICM 2019).

Today, the textile industry uses more than 8,000 harmful chemicals in its supply chain and faces intense pressure from non-governmental organizations for cleaner production (Nimkar 2018).

The damage caused by the use of hundreds of synthetic textile fibers, dyes and coatings, polymers, adhesives, perfumes, and synthetics is now insurmountable (Nimkar 2018).

Indeed, the chemical footprint created by the industry has now become a threat to the planet. Reducing this footprint is possible by considering the entire value chain. As a cooperation program developed for this purpose, ZDHC has adopted the principle of systematically transforming the textile industry in particular. In the long term, sustainable chemicals are considered the only key to environmental protection and the continuation of the industry (ZDHC-MRSL Principles and Procedures).

Table 1. World share of countries export, importers coloring matter of vegetable or animal origin (2019) (oe:World).

| <i>Exporter</i> | <i>World Share %</i> | <i>Exporter</i> | <i>Value</i> | <i>Importer</i> | <i>Value</i> | <i>Country</i> | <i>Highest Import Tariff %</i> | <i>Country</i> | <i>Lowest Import Tariff %</i> | <i>Country</i> | <i>Madder Obtained (tons/hectare)</i> | <i>Company Name</i> | <i>Price per kg</i> |
|-----------------|----------------------|-----------------|--------------|-----------------|--------------|----------------|--------------------------------|----------------|-------------------------------|----------------|---------------------------------------|---------------------|---------------------|
| China | 15.8 | China | \$223 | United States | \$169 | Bahamas | 40.2 | Angola | 0 | Turkey | 2,24 -5,55 | The Mazi | 62,2 \$ |
| Netherlands | 11.4 | Netherlands | \$161 | Germany | \$100 | Bermuda | 25.0 | Kenya | 0 | Italy | 3,5 | Kremer Pigments | 39 \$ |
| United States | 7.66 | United States | \$108 | Spain | \$82 | Pakistan | 15.7 | Mauritius | 0 | Netherlands | 6,7 | Kraft Kolour | 109,45 \$ |
| Denmark | 7.25 | Denmark | \$102 | Netherlands | \$78.2 | Nepal | 14.8 | Rwanda | 0 | France | 6,16 | Herb Co. | 30,3 \$ |
| Spain | 6.73 | Spain | \$95.1 | United Kingdom | \$73.9 | Azerbaijan | 14.4 | Tanzania | 0 | | | Natural Dyes | 20,5 \$ |

Sustainable input management

Input management that includes safer chemical components is a must in today's economies. With ZDHC MRSL (restricted harmful substances), the use of 191 hazardous chemicals, especially used in the clothing and footwear industry, is prevented. Instead of these hazardous chemicals, it is encouraged to use both more economical and more environmentally friendly alternatives as inputs (MRSL2–0).

This type of production and input management also creates a competitive effect and improves environmental standards. The rapid increase in the demand for environmentally friendly products in global markets leads not only multinational but also local manufacturers to use techniques and technologies that do not harm the environment. Therefore, companies gain a competitive advantage in global markets by producing “green products” (Gul 2015).

Developing countries that want to sell goods to countries with high environmental standards such as the European Union and the United States have to produce by taking these environmental criteria into account.

There is no other way they can meet the demand. At this point, production processes in which the harmful chemicals used in textiles are reduced or alternative safe inputs are preferred instead come to the fore (Cosbey 1996).

“Detox my fashion” approach

Global fashion brands produce more products than the world's resources and environment can handle. According to Greenpeace what is a “trend” today becomes easily “garbage” tomorrow and it has a serious impact on textile production. So a paradigm shift is needed (GREENPEACE).

The roadmap in this paradigm shift can be formed by minimizing the use of harmful chemicals that are mandatory in the production or to safer and more economical alternative inputs (ZDHC-MRSL Principles and Procedures).

A holistic approach to sustainable chemical management global brands shares the ZDHC vision. More than 160 global companies that have signed the ZDHC protocol. Some major brands like Asos, Adidas, BASF, C&A, Burberry London, Coats, Esprit, G-Star Raw, Gap inc.H&M, Hugo Boss, Inditex Group (Zara,Pull and Bear,Bershka), Levi Strauss Co., Marks and Spencer, New Balance, Primark, Puma, Target and Tchibo can be mentioned.

Materials and methods

For the product parameter obtained per hectare used in the calculations in this part of the study, “Baydar and Karadoğan’s “Agronomic Potential and Industrial Value of Madder (*Rubia tinctorum* L.) as a Dye Crop” was used. 2006). According to the study, 4.8 tons/hectare (4800 kg/hectare) product is obtained.

According to Dominique Cardon (2007), the amount of madder obtained per hectare in Turkey, Italy, Netherlands and France is given below.

In Turkey 2,24–5,55 tons of madder (*Rubia tinctorum* L.) obtained per hectare. In Italy 3,5 tons of madder (*Rubia tinctorum* L.) obtained per hectare. In Netherlands 6,7 tons of madder (*Rubia tinctorum* L.) obtained per hectare. In France 6,16 tons of madder (*Rubia tinctorum* L.) obtained per hectare.

The reason for using the mentioned data is to determine the active dyestuff ratio. According to Cardon's study (Cardon 2007), this rate is approximately 8%. So in the calculation below, the rate is taken as 8%.

$$4800 \text{ Kg (in per hectare)} \times 0,08 \text{ (percentage dyestuffs)} = 384 \text{ Kg (dyestuffs)}$$

Madder (*Rubia tinctorum* L) obtained per hectare is 4,8 tons and the amount of dyestuff obtained per hectare 384 kg/hectare

The use of the active ingredient in madder, which is used in coloring textile products, is 0.1% on average. This means that 1 kg of active dyestuff is used for 1000 kg of fabric.

$$384 \times 1000 = 384.000 \text{ Kg}$$

According to this result, 384 tons (384,000 kg) of fabric can be dyed with the madder obtained from 1 hectare.

Results and discussion

In the next stage of the study, a commercial value will be determined by calculating the average of the material prices obtained from various producers/sellers.

The producers/sellers where prices are collected from and the prices are as follows (themazi, kremerpigments, kraftkolour herbco, naturaldyes):

Companies, The Mazi gives 62,2 \$ per kg. Kremer pigments gives 39 \$ per kg. Kraft Kolour gives 109,45 \$ per kg. Herb Co. gives 30,3 \$ per kg. Natural Dyes gives 20,5 \$ per kg.

When the average of the prices given above is taken, the result is \$ 52.29. Therefore, the current commercial value of the substance can be considered as 52.29 per kilogram. This price is an important value in terms of revealing the income generating feature of the madder.

Conclusion

As a result of urbanization, with the migration of the population from the villages to the cities, agriculture could not be done in agricultural areas. The village areas have turned into unproductive lands and had become pastures. It is very important on two issues these areas to the cultivation of madder, which has high value-added and to make them reproducible. The first of these is new agricultural areas and new employment. The other is the cultivation of environmentally friendly dyestuff resources instead of some textile dyestuffs that are toxic, carcinogenic, and cause environmental pollution. Madder dye plant cultivation is extremely easy and can be produced because it is a plant that does not require constant labor and hoeing.

The cultivation of madder will contribute to the creation of employment and the development of technology. As technology and mechanization will replace traditional methods for madder planting and harvesting. Existing technologies or modifications will be applied in this field for the extraction of dyestuffs from madder and their active ingredients. Since the pulp of madder can be applied in agricultural areas as fertilizer, the waste output will also be prevented.

Existing textile coloring machines will be adapted with some modifications or new processes and software will be developed

The madder plant is one of the least consuming of the necessary water among other agricultural products. Thus, a minimum amount of water will be used in the cultivation of the plant and savings will be provided from water resources. In textile coloring with madder, the amount of water is less than conventional coloring and it provides a saving of 75%. The same percentage of savings is achieved in the amount of wastewater. In terms of saving energy, labor, and time, madder provides 50%-75% compared to conventional coloring.

Disclosure statement

No potential conflict of interest was reported by the author(s).

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