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EXPERIMENTAL PAPER

Coreopsis tinctoria Nutt. as a source of many colours

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Summary

Introduction: *Coreopsis tinctoria* Nutt. is an annual plant with small flowers in yellow and claret. In dyeing process, a whole range of colours can be obtained using various methods.

Objective: The aim of the study was to present a wide range of colors of the little-known plant *C. tinctoria*. and its health promoting properties.

Methods: In our research, we selected 3 types of wool: Polish Merino, Żelaźnieńska, and Polish Lowland Sheep and compared the colours obtained on these wools using 6 dyeing methods.

Results: The results indicate that the basic colour of wool influences the intensity of colour after dyeing as well as the type of the used mordant, which determines the obtained colour. A whole range of very intense colours was obtained from very small flowers of *C. tinctoria*.

Conclusions: Flowers are a very good and efficient raw material that gives intense colors on wool. An additional advantage is the plant's health-promoting properties. The plant is still little explored in this respect.

Key words*: **Coreopsis tinctoria Nutt., sheep wool, natural dyeing, mordants, medicinal properties***

Słowa klucze*: **Coreopsis tinctoria Nutt., wełna owcza, naturalne barwienie, właściwości lecznicze***

INTRODUCTION

Coreopsis is known as a dyeing plant, but has been also used in medicine. *Coreopsis tinctoria* Nutt. (Golden tickseed) belongs to *Asteraceae* family [1-5]. It is a plant native to North America. Its name is taken from the Greek ”koris”(bug) related to the shape of seed [6]. Another name of the plant is tick-seed. It occurs wild in the natural state in North America (from Saskatchewan and Minnesota to Louisiana, Texas and Arizona). It is also spread in Asia and New Zealand. In many countries it is grown as an ornamental plant on flowerbeds, in gardens as well as in green roof gardens [7]. The plant was introduced in Europe in 1835. It is cultivated in

Spain, Poland, Portugal, Serbia, Great Britain, Austria, Belgium and other countries.

The plant grows about 50 cm tall. The flowers are interestingly coloured: the petals are bright yellow with claret and brown centres. It blooms from June to September. For dyeing purposes, the flowers are harvested in this period, whereas the seeds from June to October. In Great Britain, coreopsis is sown on meadows and roof gardens. It perfectly grows in these not very favourable conditions and also blooms for several months.

Compounds of *Coreopsis tinctoria* Nutt.

The following compounds were separated in inflorescences *C. tinctoria*: different flavonoids (marein, flavanomarein, quercetagetin-7-O-glucoside, okanin aurone, leptosidin, luteolin, apigenin), organic acids (3,4-dihydroxybenzoic acid, 4-hydroxybenzoic acid, chlorogenic acid and caffeic acid), organic ester: 4-*O*-*β*-D-glucopyranosyl-*p*-coumaric acid methyl ester. The plant contains also: two flavonones: 2S-3', 5', 7-trihydroxyflavanone and (2R, 3R)-3,4',5,7-tetrahydroxyoflavanone and two sterols: stigmasterol-3-*O*-*β*-D-glucopyranoside and *β*-sitosterol. A group of scientists in China have discovered the new compound called okanin [8-10].

Medicinal properties

In folk medicine, the plant has been used to treat many conditions, such as bleeding, to control diabetes, and also as a vomiting agent as well as to treat diarrhoea (extract from the whole plant) and cardiovascular diseases. *C. tinctoria* flower is used as a drink and as a nutriment to reduce weight, high lipids and high blood sugar and improve the condition of the liver [11].

In traditional Indian, Chinese and Portuguese medicine, *Coreopsis* has been used for hundreds of years to treat many diseases. Tea flower infusions were used as a drink to treat hypertension [8] and hyperglycaemia. In the Department of Pharmacy, Guangdong, Provincial People's Hospital Guangzhou in China the research there was conducted on the assessment of antioxidant activity of the plant's flowers [12-14]. Other studies have shown that flavonoid-rich plant flowers increase glucose tolerance by restoring pancreas functions in streptozotocin-induced diabetic rats [15]. According to another China researches, flavonoids from *C. tinctoria* extracts showed anti- hyperlipidaemia effect, particularly in lowering triglycerides, reducing lipid deposition and protecting the liver function [9, 15].

Pharmacological studies have shown that *Coreopsis* has certain biological effects, including antioxidant [7, 12], antidiabetic [7, 14], antihypertensive [7], and cytoprotective [14].

As a result of these studies, therapeutic properties were discovered in the plant flowers, which requires further research. Nevertheless, it has been stated that the plant is a valuable raw material for food industry.

Sheep wool is a natural and biodegradable product obtained during shearing from sheep of many breeds. White and uniform wool plain wool are of the largest demand, because it is a raw material for crafters as well as for textile industry [17]. Currently, sheep wool and its fabrics are perceived as an ecological product used for the production of clothes and upholstery fabrics as well as used by artists to create works of art that can be seen in galleries, museums and public places. Sheep wool usually has a white or slightly creamy colour, so it is easy to be dyed any colour.

MATERIALS AND METHODS

The plant material

Flowers and tips of plants were harvested at the Experimental Stations of the Institute of Natural Fibres and Medicinal Plants in Pętkowo and in the Garden of Medicinal Plants of the Institute in Plewiska, Poland. The seeds of the plant were sown in spring. Harvesting was carried out during the flowering period from June to September. Flowers were dried at 30°C. The dried flowers of the plant were used to create dyestuffs.

Wool

In these studies, the samples of washed wool coming from Polish sheep breeds with the thinnest and plain wool were used. These include: Polish Merino, Żelaźnieńska and Polish Lowland Sheep, taking into account the basic colour of wool [17, 18]. Laserscan was used to measure the thickness of the wool.

Table 1 presents the most important quality parameters of wool valuable for textile industry. Out of three breeds of sheep whose wool was used in the

Table 1.

Quality parameters of wool of selected sheep breeds

Wool sample	Diameter	SD	CV	SF	Curvature	CF	Prickle factor	Length	SD
	[μm]	[μm]	[%]	[μm]	[deg/mm]	[%]	[%]	[mm]	[mm]
Polish Merino	24.9 (24.3÷26.2)	5.31	21.2	24.4	108.34 (105.2÷109.4)	86.9	13.1	68.0	9.5
Żelaźnieńska	29.3 (29.1÷29.7)	6.78	23.2	29.1	85.96 (84.1÷87.7)	58.82	41.2	86.5	6.3
Polish Lowland Sheep	31.9 (31.8÷32.2)	7.36	23.0	31.7	94.94 (91.0÷98.6)	42.84	57.2	85.0	9.0

SD – standard deviation
CV – coefficient of variation
SF – spinning fineness
CF – comfort factor

research, the best material was derived from Polish Merino. It was characterized with the smallest thickness of 24.9 μm, standard deviation (SD) 5.31 μm, and a coefficient of variation (CV) of 21.2%, respectively. Spinning fineness (SF) provides information on the processing value of wool and the benefits for buyers and processors. In the case of Polish Merino, this parameter reached 24.4 μm. The curvature of this wool was high,108.34 deg/mm. The comfort factor (CF) was 86.9% indicating a large proportion of fibers with a thickness higher than 30 μm, which is reflected in Prickle Factor 13.1%. Polish Merino was also longer than other types of wool, on average 9.5 mm.

The basic colour of wool was measured with a Konica Minolta cr-400 colourimeter using a standardized international method (Commission Internationale de l'Eclairage) CIELab, according to which L^* describes the brightness of colour in the range from white (100) to black, a^* describes the saturation of colours from red to green, b^* describes the saturation of colours from yellow to blue. Tables 2, 3, and 4 present measurements of colours obtained on dyed wool according to two color description systems: spectrophotometric analysis and assessment of colour, according to Pantone Color System.

Tables 2, 3, 4 present colours in CIE Lab System. The CIE Lab colour space (also known as CIE L*a*b* is a colour space defined by the International Commission on Illumination (CIE) in 1976.

The Pantone® Colour Matching System is a standardized colour reproduction system. By standardizing the colours, different manufacturers in different locations can refer to the Pantone® system to assure the

Table 2.

Analysis of the colours obtained on Polish Merino wool

POLISH MERINO						
Sample No.	MORDANT	COLORIMETER RESULTS			COLOUR	PHANTONE®
		L*	a*	b*		
0	raw wool	82.92	–0.55	9.63	ecru	11–4001 TCX
1	no mordant	53.26	22.19	48.87	sunflower	16–1054 TCX
2	alum	64.98	7.56	54.1	gold maize	15–0751 TCX
3	sodium carbonate	36.09	37.06	25.32	dark rusty red	18–1354 TCX
4	citric acid	71.55	–3.42	58.52	lemon yellow	12–0752 TCX
5	copper sulphate	42.51	23.50	32.38	light brown	17–1046 TCX
6	iron sulphate	34.41	4.88	16.7	olive brown	18–0832 TCX

L* – lightness
a* – redness
b* – yellowness

Table 3.

Analysis of the colours obtained on Żelaźnieńska wool in dyeing process

ŻELAŹNIEŃSKA						
Sample No.	MORDANT	COLORIMETER RESULTS			COLOUR	PANTONE®
		L*	a*	b*		
0	raw wool	83.87	0.18	9.8	white	11–0106 TCX
1	no mordant	56.36	19.28	50.63	brown yellow	15–0953 TCX
2	alum	72.03	1.19	53.83	mustard	13–0752 TCX
3	sodium carbonate	42.31	38.64	32.2	light rusty red	17–1452 TCX
4	citric acid	76.74	–7.77	55.4	lemon yellow	12–0752 TCX
5	copper sulphate	41.06	20.46	31.02	light brown	17–1046 TCX
6	iron sulphate	39.11	2.01	20.66	olive brown	17–0636 TCX

L* – lightness
a* – redness
b* – yellowness

Table 4.

Analysis of the colours obtained on Polish Lowland Sheep wool in dyeing process

POLISH LOWLAND SHEEP						
Sample No.	MORDANT	COLORIMETER RESULTS			COLOUR	PANTONE®*
		L*	a*	b*		
0	raw wool	76.13	0.5	16.62	golden cream	13–0919 TCX
1	no mordant	51.72	19.38	46.94	golden yellow	15–0953 TCX
2	alum	55.31	15.34	50.14	nugget gold	16–0952 TCX
3	sodium carbonate	35.84	31.8	26.67	rusty red	16–1449 TCX
4	citric acid	68.71	–1	57.86	maize	13–0746 TCX
5	copper sulphate	36.65	20.12	27.73	light brown	18–1160 TCX
6	iron sulphate	40.17	5.14	27.73	olive brown	17–0840 TCX

L* – lightness
a* – redness
b* – yellowness

colour match without direct contact with one another.

Wool thickness and statistical quality parameters depending on the breed are presented in table 1. The thinnest wool of the 3 selected varieties is Polish Merino. Żelaźnieńska wool has the purest and whitest colour. All samples of the washed wool were subjected to premordanting. Dissolved alum (alum - potassium aluminium sulphate $KAl(SO_4)_2 \cdot 12H_2O$) was added to the water, temperature 60°C, and next the wool was added to this solution. The proportions were as follows: 8% alum – 100 g wool fibres. After the pre-mordanting process, it was the time for dyeing with *Coreopsis* flowers without additives and with the use of mordants: alum, soda, citric acid, copper sulphate and ferrous sulphate.

The result of colours obtained in Polish Merino, Żelazieńska and Polish Lowland Sheep wool in dyeing process can be found in tables 2–4.

Ethical approval: The conducted research is not related to either human or animal use.

RESULTS AND DISCUSSION

The results of wool dyeing with *C. tinctoria* depending on the sheep breed and the used dyeing

mordants are presented in tables 2–4.

Among the mentioned breeds of sheep, the brightest wool was obtained in Polish Merino and Żelaźnieńska. The measurement of colour with a colourimeter indicated that the most intense colour was obtained with use of sodium carbonate for the wool from Polish Merino breed – pure red, whereas Żelaźnieńska and Polish Lowland Sheep obtained brick-red colour.

The use of citric acid in the dyeing process of the Polish Merino and Żelaźnieńska wool gave the lemon yellowish colour, whereas the Polish Lowland Sheep wool – warm yellow. The results indicate that the basic colour of wool influences the intensity of colour after dyeing as well as the type of the used mordant, which determines the obtained colour. A whole range of very intense colours was obtained from very small flowers of *C. tinctoria*.

In conclusion, the mordant used for dyeing showed differences in colour and changes in the L* brightness index similar to the results of study [1], although another plant was used for dyeing.

Conflict of interest: Authors declare no conflict of interest.

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