



Indigenous knowledge on the uses, management, drying and marketing of *Celosia cristata* L.- A culturally significant flower of the Kashmir Valley, India

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Cockscomb flower (*Celosia cristata*), commonly known as 'Marwal', is an important part of Kashmiri culture. However, it has received little attention from researchers. In the present study, an effort has been made to document the indigenous knowledge of the native Kashmiri population about its ethnobotanical uses and bring this valuable plant into focus. The indigenous knowledge about *C. cristata* was gathered by adopting Participatory Rural Appraisal technique. It involved interviews, and discussions with a total of 55 respondents. All the documented data was quantitatively analyzed using several ethnobotanical indices including Use Value (UV), Fidelity Level (FL), Informant Consensus Factor (F_{IC}) and Index of Cultural Significance (ICS). The results revealed that the flower plays a crucial role in folklore medicine, local cuisine, and beautification of surroundings, and most importantly as a food colorant, which can serve as an alternative to the harmful synthetic color additives used in food industries. This innovative practice developed by the Kashmiri people need to be well protected. In addition, extensive studies are required to investigate, identify and characterize the biologically active compounds responsible for the pharmacological effects of *C. cristata*.

Keywords: Cockscomb flower, Ethnobotanical indices, Indigenous knowledge, Kashmir

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Since the beginning of civilization, people have been using plants as food, fodder, and medicine. Different ethnic groups utilize plants in their own ways¹. Native communities around the globe have a great understanding and knowledge about locally available plants. The study of the intricate relationship between (utilization of) plants and cultures is of significant importance which promotes the use of underutilized plants for food, medicine, cosmetics, and other industrial products. This study is known as "Ethnobotany", which has been evolved as a distinct branch of natural sciences and has undergone a true revolution in the 20th century². It is the study of the classification, use, and management of plants by the people, and it includes a range of disciplines, including natural and social sciences, to show how conservation of plants and local knowledge about them can be achieved³. The importance of ethnobotanical studies is manifold, as these provide valuable data on life support services, new uses not recorded in literature, new vernacular names, distributional areas of new medicinal plants, and conservation practices. Indigenous knowledge about the use of plants by the native people is passed from

one generation to the next orally without proper documentation. However, recently much interest and attention are being paid by the researchers towards gathering and preserving this valuable information. Appropriate and systematic documentation can therefore help in conserving the medicinal plant species which would prove to be a beneficial tool for utilizing these plants and their bioactive component in modern pharmacopeia.

A wealth of information on ethnobotany exists in India since the ancient times. India harbors a total of 47,513 plant species represented by more than 3000 medicinal plant species⁴. Northern India is geographically predominated by the Himalayan range which stands between the Indian subcontinent and the Tibetan plateau. The Kashmir valley lies in the northern part of India, and is surrounded on the North and East by the main Himalayan range while the Pir-Panjal Range borders it from the south and the west⁵. Owing to its varied climate and topography, Kashmir valley has a rich diversity of medicinal flowers, plants, and herbs. Many studies have been carried out to chronicle the traditional wisdom of numerous indigenous plants and flowers of the valley. But

C. cristata has received very little attention. In our present study, an attempt has been made to assess the knowledge of local inhabitants of the Kashmir valley regarding the use of *C. cristata* (Fig. 1; Supplementary Fig. S1) as a food and medicinal plant and thereby to document the knowledge about its use in folklore medicine by the traditional healers of Kashmir region.

Methodology

Study area

The valley is divided into 10 districts out of which Srinagar (34° 5' 1.1616" N and 74° 47' 50.5356" E), Budgam (34° 37' 48.00" N and 76° 02' 24.00" E) and Baramulla (34° 12' 7.7328" N and 74° 20' 53.7324" E) were selected for conducting the ethnobotanical survey on the grounds that these are some of the densely populated and oldest inhabited regions of Kashmir (Fig. 2). These three districts were chosen as pilot sites considering that the majority of knowledgeable and renowned traditional healers

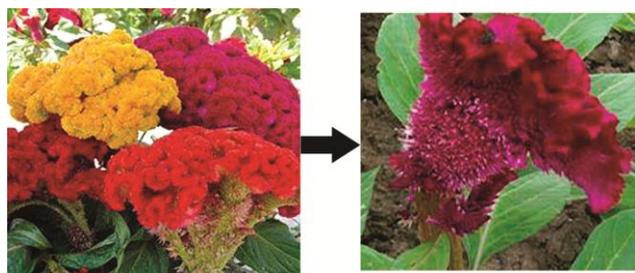


Fig 1 — Different inflorescences of *Celosia cristata*.

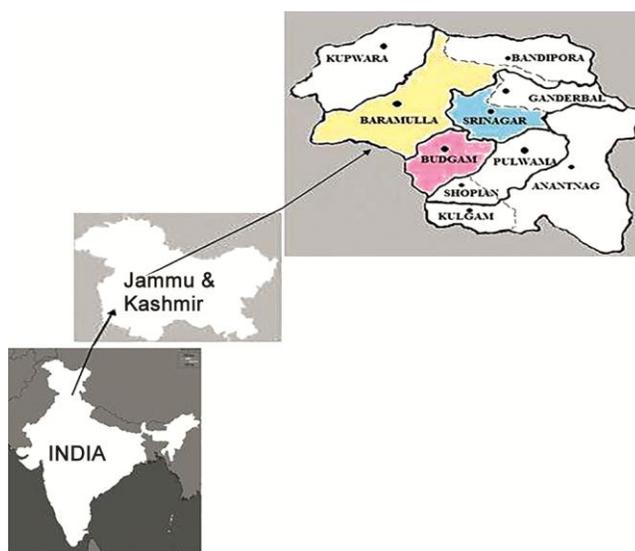


Fig 2 — Location map of area under study showing different districts of Kashmir Valley.

(hakims) live and practice in these areas. For collecting relevant and robust data, regular forays were carried out in the areas of Nowhatta, Lal Bazar, BohriKadal, Rawalpura (District Srinagar), Bathara, Parnewa (District Budgam), Tangmarg, Tarhama and Dobiwan (District Baramulla).

Data collection

The indigenous technical knowledge (ITK) of *C. cristata* was gathered by adopting Participatory Rural Appraisal (PRA) technique. It involved interviews, and discussions with the local traditional healers (hakims), local informants, traditional chefs (Wazas) and horticulturists. A total of 55 respondents were interviewed to collect information related to cultivation, drying, storage, consumption, culinary, medicinal and ornamental uses. The key respondents included 10 herbalists, 10 local chefs, 10 local horticulturists and 25 local inhabitants (both Kashmiri Pandits and Muslims). The collection of data regarding ethnomedicinal uses of any plant is a challenging task because majority of the traditional practitioners do not want to disclose their remedies and recipes. Therefore, prior consent for publishing the information was obtained from the healers who agreed to participate and share their traditional wisdom with us. All the relevant information was carefully recorded on semi-structured questionnaires.

Data Analysis

The gathered ethnobotanical data was analyzed using the following quantitative tools/ indices:

Index of Cultural Significance (ICS)

The value of the Index of Cultural Significance (ICS) was calculated using the formula developed by Turner⁶. Analysis of this important ethnobotanical index uses three components namely the quality of use, the intensity of use and exclusivity of use.

$$ICS = \sum_{i=1}^n (q * i * e)$$

Where

ICS = Index of Cultural significance, q = quality of use (0 to 5), i = intensity of use (0 to 5) and e = exclusivity of use (2-1-0.5).

Informant Consensus Factor (F_{IC})

The Respondent or Informant Consensus Factor (F_{IC}) was calculated to determine the homogeneity of information gathered during the fieldwork^{7,8}. The values of F_{IC} range from 0.00 to 1.00. High F_{IC} values

(near 1) are obtained when the selection criterion in the community is well defined and/or when single or a few plant species are documented to be used by a large number of respondents for a specific purpose.

F_{IC} was calculated by using the formula:

$$F_{IC} = \frac{Nur - Nt}{Nur - 1}$$

Where,

F_{IC} = Informant Consensus Factor, Nur = number of used citations in each category and Nt = number of species used.

Use Value (UV)

The Use Value (UV) determines the relative importance of plant species known locally. It was calculated according to the given formula by Phillips and Gentry⁹.

$$UV = \frac{\sum U}{N}$$

Where,

UV = Use Value of species, U = the number uses recorded for the species and N = total number of informants.

The Fidelity Level (FL)

Fidelity Level (FL) is a quantitative method that measures the importance of a species for a given purpose. It's a helping tool that identifies the key informants' most preferred method of using the plant species for food or medicinal purposes. The fidelity level was calculated by using the formula proposed by Friedman and co-workers¹⁰.

$$FL (\%) = \frac{I_p}{I_u} \times 100$$

Where,

FL = Fidelity level, I_p = the number of informants who cited the species for a particular use, and I_u = total number of informants that mentioned the plant for any use.

Results

Ethnobotanical Data

Culinary and Medicinal Potential

The inventory for this group included questions on consumption, local recipes, ethnic use in food and medicine, plant part used and mode of preparation. Although, *C. cristata* is highly valued as an ornamental plant, yet no mention was found its

cultivation on account of its flower being eaten. The leaves, on the other hand, offer spinach-like flavour and basil like texture which can be eaten in dishes prepared with various green leafy vegetables.

With respects to culinary use, Kashmiris have found a unique way of using *C. cristata* as a natural food colorant in local dishes. This invention dates back to the 14th century when *wazwan* as a cuisine was introduced in Kashmir under Mongolian rule^{11,12}. It imparts a fiery hot color to gravies, without affecting the taste and aroma of the dish. The decoction is prepared by grinding the dried flowers, extracting the color with warm water and straining to remove any residues. The resulting extract is added directly to the dishes (Fig. 3). Various culinary uses of *C. cristata* have been given in Table 1. Utilization of cockscomb leaves as a nutritious green leafy vegetable has been reported by Yargos¹³. However, its use as a food colorant could not be found in any literature, which suggested that Kashmiri cuisine was probably the first to have *C. cristata* added as a color enhancer in local dishes.

Different parts of *C. cristata* are used as medicines by traditional healers. Among these, the dried flowers are used more frequently. The flowers are procured from reliable sources in mostly dried form and stored carefully until use. The healer takes special care in handling and grinding the flowers. The grinding is carried out by the healer in his dispensary (Fig. 4). The dried, powdered flowers are then stored in well labeled airtight pouches or containers to avoid accidental mixing with other powders. It is used to treat leucorrhea, arthritis, fatigue, cardiovascular problems, hemorrhoid bleeding and other ailments (Table 2). These results are in agreement with the



Fig 3 — Extract of *Celosia cristata* flowers used for coloring food.

Table 1 — Culinary use of *Celosia cristata* L.

S.No.	Culinary Use	Mode of preparation	I _P	I _U	Fidelity Level (%)
1	As a green leafy vegetable	Cooked with spinach, collard leaves (haakh) and onion.	15	35	42.85
2	As a food colorant	Extract of powdered shade dried flowers is prepared with warm water, strained and used to color curries (meat based) like rogan josh, rista etc.	35	35	100

Table 2 — Ethnomedicinal uses of *Celosia cristata* L.

S. No.	Ethnomedicinal uses	Part of the plant used	I _P	I _U	Fidelity level (%)
1.	Diarrhoea	Flower	07	10	70
2.	Dysentery	Seed, leaves	06	10	60
3.	Heavy menstrual bleeding	Flower, seed	10	10	100
4.	Leucorrhoea	Flower	10	10	100
5.	Bloodshot eyes	Seed	05	10	50
6.	Blurry vision	Seed	05	10	50
7.	Hypertension	Flower	10	10	100
8.	Cardiovascular	Flowers	10	10	100
9.	Internal Hemorrhage	Flower	10	10	100
10.	Liver Heat	Seed	04	10	40
11.	Treatment of Helminths	Flower, leaves	08	10	80
12.	Hemorrhoid Bleeding	Flowers	10	10	100



Fig 4 — A traditional healer making “safoof”, in his “Dawakhana” or “Dispensary”.

results of some of the prominent researchers who have gathered similar data on the ethnomedicinal aspects of *C. cristata*¹⁴⁻¹⁶.

Ethnomedicinal preparations

It has been reported that 25% of medicaments manufactured in the developed countries are emanated from plants¹⁷. This suggested that plants and their derivatives play a critical role in the development of modern drugs. In spite of the fact that synthetic drugs offer rapid action, decreased production cost and time, and effective quality control, their efficacy and safety have always remained questionable.

According to WHO reports, the global market for herbal and plant-based medicine is estimated to grow at a rate of 15-25% annually. This upsurge in the demand for herbal medicine suggests the need for commercial exploitation of plants and herbs possessing active metabolites in desired concentrations. *C. cristata* can prove to be a potential source of such bioactive compounds. The survey revealed that traditional healers mostly use flowers, followed by seeds and leaves for formulating different ethnomedicines (Supplementary Fig. S2).

The major methods of preparation of traditional medicines/remedies in the studied area were powdered dried flowers, decoction of seeds, and extract preparation from flowers and leaves. The powdered flowers are mostly used in the preparation of “Safoof” or “Medicine in the powdered form”. The preparation involves pulverizing various medicinal plants, herbs, and sugar in accurately weighed quantities and then taken as advised by the practitioner. A large mortar made from granite and a wooden pestle is employed for this purpose (Supplementary Fig. S3). This mixture is known as “Sufoof-e-Kaharbah” and its recipe is given in Table 3.

Ornamental use

In Kashmir, *C. cristata* is widely planted as an ornamental plant. With its striking appearance and

Table 3 — Recipe for safoof formulation.

S. No.	Vernacular name	Common name	Quantity (Grams)
1.	Taj-ul- Kharoos	Cockscomb Flower	50
2.	Samag-e-Arabi	Gum Acacia	20
3.	Kateer	Tragacanth Gum	50
4.	Tabasheer	Bamboo Silica	20
5.	Sast- e- Giloy	Moonseed	25
6.	Hajr- ul- Yahoood	Lime Silicate Calx	25
7.	Gul- e- Anar Farsi	Pomegranate Flower	50
8.	ZeharMohra	Sepertine	25
9.	Bekh-e- Anjbar	Knotgrass Roots	100
10.	Mastagi Rumi	Mastic Gum	20
11.	Sosan	German Iris	15
12.	Gil- e- Armaani	Armenian Bole	60
13.	KamarKash	Flame of the Forest	60
14.	Sang- e- Jarahat	Steatite	50
15.	Nishasta	Starch	100
16.	Bor- e- Sandaleen	Sandalwood Powder	20
17.	Kaaknaj	Bladder Cherry	30
18.	Suranjan-e- Misri	Autumn Crocus	25
19.	Keharba	Amber	50
20.	Shakkar	Sugar	750

magnificent hues of red, magenta, yellow, pink and orange, this flower adds beauty and life to otherwise boring and gloomy gardens. The red and magenta varieties are mainly cultivated for culinary and medicinal purposes. All the other varieties are strictly ornamental. These are ideal choices as border plants, fresh cut flowers, for pots, garden edges, flower beds and can be incorporated into dry bouquets.

Cultivation and management

Local horticulturists were interviewed for collecting information related to the cultivation of *C. cristata*. The questionnaire designed for this group focused on plantation technique, harvesting, and management.

The plants can be propagated easily from seeds. The best time for sowing the seed is from the months of May to July. The seeds are normally broadcast on top of the soil. Germination takes place within 2 weeks after which the plantlets are plotted into prepared beds. So, the next crucial step is getting the land prepared. The land/plot should be properly manured. The plants prefer moist, well-drained soil and grow well in sunlight and have a tendency to wilt if overly dry. Therefore, it has been recommended to water the plots every alternate day. The seedlings are sown into the plots with 6-12 inches spacing (Supplementary Fig. S4). It's important to keep a check on weeds and grass as the young seedlings can be easily smothered. Exposure to cold temperatures may cause premature blooming. The flowers are in

full bloom around September and are harvested in early October. These may be dried for culinary, medicinal or ornamental purposes¹⁸.

There are no serious disease or infestation problems associated with this plant. In poorly drained soil, it may be susceptible to diseases such as root rot and leaf spotting. Water logging and freezing temperatures may also damage the plants. Our findings on cultivation and maintenance of *C. cristata* corroborate the results reported by Gilman and Howe¹⁹.

Drying and storage

The flowers with red inflorescences are usually chosen to be dried for medicinal and ornamental purposes but 60% of the flowers are dried for its use as an active food coloring agent. The drying technique requires the cut flowers to be hung upside down in bunches of 8-10 flowers. The flowers are then shade dried under the roof in order to retain the deep red hue and all the bioactive compounds (Fig. 5). It may take several weeks for the flowers to completely dry. They are stored in open, dark and dry places until use. National research council, Washington D.C, documented similar methods for drying *C. cristata*^{19,20}.

Marketing

The flowers are largely sold in dried forms by local spice vendors known as “*Bohris*”. They are sold either in powdered form or as whole flowers (Fig. 6). The seeds are also available for sale in the market. The dried flower can be bought for USD 20-25 per



Fig 5 — Traditional way of drying *Celosia cristata* flowers.



Fig 6 — Marketing of dried *Celosia cristata* flowers.

Table 4 — Index of cultural significance of *Celosia cristata* L.

Scientific name	Vernacular name	Detailed calculation	ICS
<i>Celosia cristata</i> L.	Mawal	$(4 \times 4 \times 1) + (3 \times 4 \times 2) + (4 \times 3 \times 1)$	52

kilogram and powdered form is available for USD 32-35 per kilogram. Fresh flowers are also available for a limited period of time in the months of May to September. The plantlets can cost around USD 2-3 for a dozen.

Conclusion

The present paper brings into focus the crucial role played by *C. cristata* in folklore medicine, local cuisine, and most importantly as a food colorant which can serve as an alternative to the harmful synthetic color additives used in food industries. The use value (UV) of the plant was calculated to be 0.36 and Informant Consensus Factor (F_{IC}) was 1. The flower is being extensively used by the local inhabitants for its coloring properties with highest Fidelity value of 100%. The Index of Cultural Significance of this flower is given in Table 4 and was computed to be 52, which depicts that *C. cristata* is highly valued for its use as a natural food colorant, as well as a medicinal and ornamental plant. Efforts should be made to document the ethnobotanical uses of this plant throughout the country, as attempted in the present study so that the unexploited potential can be further explored, and the flower can be used to

extract the natural colorants. Thus, the untapped functional potential will be fully utilized.

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Conflict of Interest

Authors declare there is no conflict of interest in publishing the paper.

Author Contributions

MT: Conceptualization, Supervision, Writing - review & editing; RS: Experimental work, analysis, Writing - original draft

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