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Development of UV protective *Scoodie*

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Abstract

Sun's energy is composed of rays of invisible ultraviolet (UV) light. When this energy reaches on the earth in the form of ultraviolet light rays (UVA and UVB). These UV radiations can enter the skin, they have potential to damage skin cells, causing visible and invisible injuries resulting in increased numbers of moles, freckles, wrinkles, and skin cancers. "Sunburn" is a visible type of damage, which appears just a few hours after sun exposure. In many people, this type of damage also causes tanning, or increased pigmentation of the skin, which is noticeable a few days after sun exposure. Sun protective clothing as "clothing specifically designed for sun protection and is produced from a fabric rated for its level of ultraviolet (UV) protection". With the growing attentiveness of dangers posed to human health by overexposure to solar radiation; particularly ultraviolet components of radiation, due to the depletion of the ozone layer, efforts have been made to provide sun protective clothing while performing outdoor activities. The degree of protection offered by such clothing depends on a number of factors. In this paper, an attempt has been made to develop UV protective *scoodie* which is combination of scarf and hood. While keeping in mind that the majority of time head, face and neck area is exposed to solar radiation. The *scoodie* is designed in such a manner that it can protect these exposed areas of body. Besides this UV protection property is imparted to cotton fabric through dyeing and further this fabric is used for the development of UV protective *scoodie*. The designs of *scoodie* were appreciate by the consumer.

Keywords: UV protective *scoodie*, ultraviolet radiation, designs, consumer awareness

1. Introduction

Sunlight has played a critical role in the development of life on Earth. The infrared and visible regions of the solar radiation comprise 95% of the total radiation reaching the Earth's surface. The ultraviolet component of the terrestrial solar spectrum comprises approximately 5% of the radiant energy; however, this component is largely responsible for the deleterious effects of solar exposure. (Neale, 2023) ^[9] Ultraviolet radiation, like visible radiation (light) and infrared radiation, is radiant energy. Together, these forms of radiant energy are referred to as "optical radiation." In the optical spectrum, wavelengths are normally quantified in terms of nanometers ($1 \text{ nm} = 10^{-9} \text{ m}$) in the UVR and visible spectrum and in terms of micrometers ($1 \mu\text{m} = 10^{-6} \text{ m}$) in the infrared spectrum. The ultraviolet spectral bands are: UVC (100-280 nm), UVB (280-315 nm), and UVA (315-400 nm). Though UVA rays can accelerate aging effects on the skin and UVB rays can cause sunburns, UVC is absorbed by the Earth's atmosphere and therefore does not penetrate. (Tang et al. 2024) ^[8].

Modern-day solutions to limit the damage caused by UVR include sunscreen and sun-protective clothing. "Sunburn" is an acute injury following excessive exposure to UVR and is most pronounced for lightly pigmented skin types. Sunburn is actually not caused by heat or caustic chemicals, but is the result of a phototoxic (actinic) effect in the skin. Skin redness reaches a maximum at about 8-12 hours after exposure and fades within a few days (Hietanen, 2023) ^[6]. The red appearance of the skin (erythema) results from an increased blood content near the skin's surface. Sunburn sensitivity varies substantially with skin complexion and color, and this is reflected in the solar exposure time required to induce a sunburn reaction from 15-30 minutes of midday summer sunshine to 1-2 hours exposure for moderately pigmented skin; and those with darkly pigmented skin may not clearly show sunburn for a full day exposure. Tanning becomes noticeable within a day or two after sun exposure, gradually increasing for several days and persisting for a week (ISO/CIE, 2019) ^[3]. While sunscreen remains a popular protectant against the

sun and has been shown to reduce melanoma incidence by 50%, some studies have suggested that prolonged, routine sunscreen absorption through the skin barrier is associated with neurotoxicity, as well as detrimental endocrine and developmental effects (Karla and Jonathan, 2023)^[5].

Few studies have thoroughly investigated sun-protective clothing as a photoprotective method. Sun-protective clothing is effective in reducing UVR transmittance to the skin, with its ability to block UVR graded on the ultraviolet protection factor (UPF) scale. A UPF rating of 15, 30, and 50+ correspond to clothing that blocks 93.3%, 96.7%, and 98% of UVR transmittance, respectively. UV textiles have recently gained traction as another effective method for limiting UVR exposure (Jasmine and Erum, 2022)^[4].

To achieve high UPF values, photoprotective clothing is specifically designed with effective textile composition and dyeing patterns in mind rather than using chemical additives. UV-protective clothing typically utilizes clothing dyes, especially dyes with brighter colors, as clothing with brighter colors have been reported to reflect UVR by The Skin Cancer Foundation (Jasmine and Erum, 2022)^[4].

In the present study an effort is made to develop UV protective *scoodie* using naturally dyed cotton fabric to protect from the UV radiations. Different types of *scoodie* designs were developed to protect the face and neck area which comes frequently in direct contact with sun radiations and remain exposed for long duration.

2. Materials and Methods

1. Development of self -structured evaluation

performa: Three different self-structured evaluation proforma were developed to collect consumer's awareness regarding UV radiation, UV protective clothing, harmful effects of UV radiation, UV protective *scoodie designs* and developed UV protective *scoodie*.

2. Selection of *scoodie* designs: A preferential choice index was developed to obtain the preferences of thirty consumers regarding the developed *scoodie* designs on three-point rating scale i.e. highly preferred, preferred and somewhat preferred scoring 3, 2 and 1, respectively. Weighted mean scores were calculated and on the basis of scores obtained, rank was assigned to each design. Top ranked three designs were selected for development of *scoodie*. Using the measurements, the selected designs, paper patterns of *scoodie* were prepared in CorelDRAW software. With the use of developed paper patterns for different selected *scoodie* designs i.e. Design No.1, Design No.4 and Design No.5.

3. Development of *scoodie* designs: Accurately weighed

cotton samples were introduced into the mordanting bath containing 3% of mordant (Ferrous Sulphate-Myrobalan) on weight of fabric in water. The treatment was carried out for 1 hour at 60 °C. The samples were then removed from the bath, squeezed and dried without washing. The dyeing of pre-mordanted cotton fabric was done with natural dye. The cotton fabrics were dyed with the dye extract at M: L ratio of 1:30. Dyeing was carried out at 80 °C and continued for 1 hour.¹³ The highest UPF value (27.69) was found for ferrous sulphate-myrobalan treated curry dyed cotton fabric, indicating the fabric would provide very good protection. For the development of UV protective *scoodie*, the ferrous sulphate-myrobalan mordanted curry leaves dyed cotton fabric was used. Different designs for *scoodie* were developed using CorelDRAW software. Afterwards the paper pattern was developed using the measurements and key features of *scoodie*. The cutting of dyed cotton fabric was done as per the paper pattern developed. Then the stitching of the UV protective *scoodie* was done.

4. Assessment of consumers' acceptance for developed UV protective *Scoodie*:

The consumers' acceptance for developed *scoodie* was assessed based on the product designing techniques including fabric type and constructional features, colour, dye used and appearance. The opinion of consumers were also obtained regarding the developed *scoodie* in relation to suitability, ease of carry and trend etc. with the help of self-structured assessment index. The opinions of consumers were assessed in percentage.

5. Assessment of market potential of developed UV protective *Scoodie*:

The cost acceptability of developed UV protective *scoodie* was assessed for actual price of developed *scoodie* and consumer opinions were obtained about their cost acceptability in terms of highly appropriate, appropriate and somewhat appropriate. The data was calculated using percentages and weight mean score (WMS). To assess the market potential of developed products, quoted price of each product was calculated by adding 20% profit to the actual cost. The consumers were asked to give a preferred price for buying the particular product. The average selling price for each product was calculated to find the percent profit.

3. Results and Discussion

Assessment of consumers' awareness regarding effect of UV radiations on human health and UV protective *scoodie*:

The responses of consumers were recorded and the results are presented in Table 1.

Table 1: Consumers' awareness regarding UV protection and UV protective clothing/accessories n=30

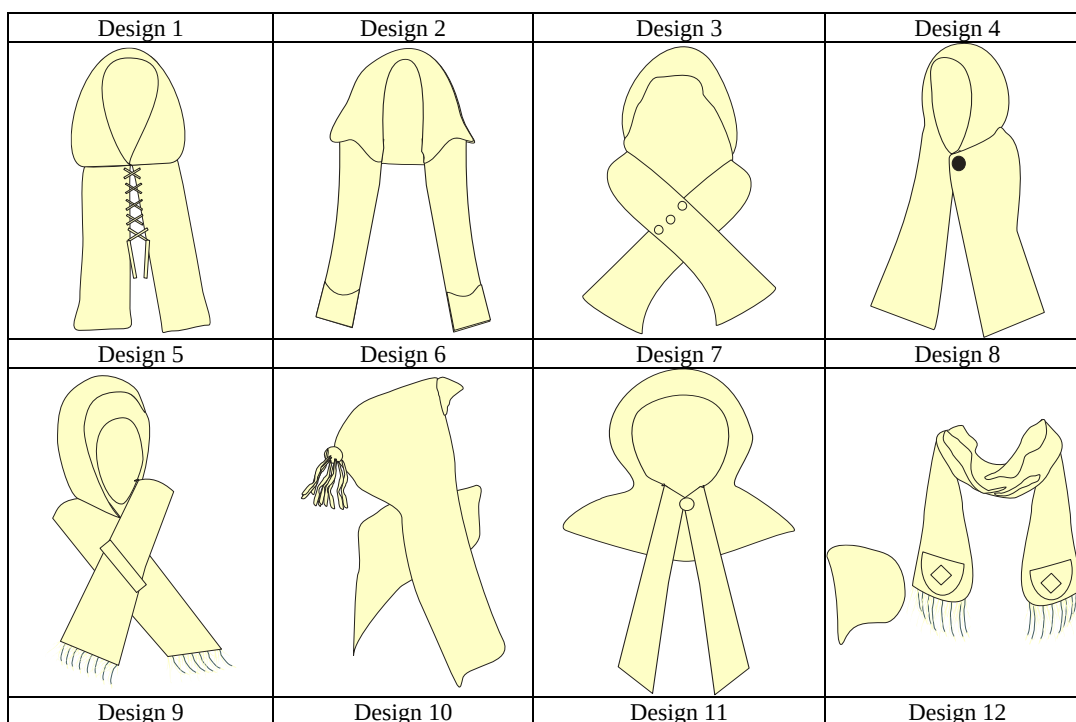
S. No.	Statements	Yes F (%)	No F (%)
1.	Awareness about UV index and level of protection required for UV radiations	07(76.70)	23(23.3)
2.	Awareness about UV protective clothing and accessories	17(56.70)	13 (43)
3.	Availability of UV protective clothing and accessories in their wardrobe	04(13.30)	26 (86.7)
4.	Awareness about Harmful effects caused by UV radiations*		
	a. Skin problems	28(93.33)	-
	Skin itching/allergy	09(32.14)	-
	Skin redness/rashes	07(25.00)	-
	Sun burning /tanning /pigmentation	16(57.14)	-

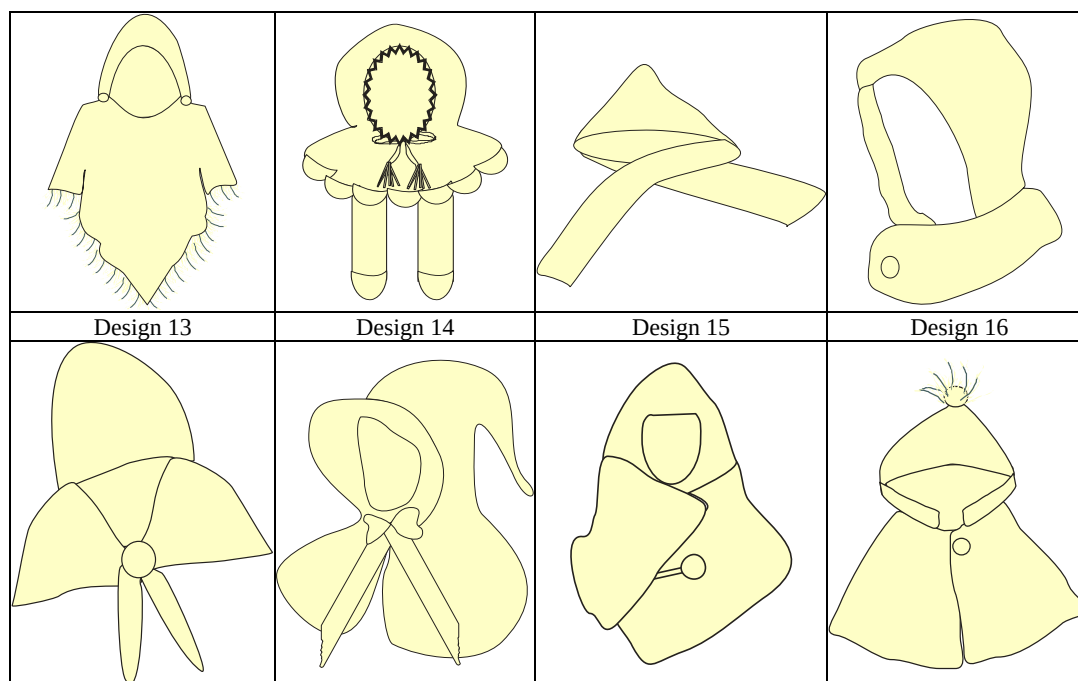
	Skin cancer	14 (50.00)	-
	b. Eyes problems	21(70.00)	-
	Eyes redness/watery eyes	11(52.38)	-
	Eyes itching/irritation	06(28.57)	-
	Cataracts /conjunctivas	01 (4.76)	-
	Vision	02(9.52)	-
	Corneal damage	02 (9.52)	-
	c. Immunity problems	08 (26.70)	-
5.	Knowledge about UPF value of clothing	04(13.30)	26 (86.7)
6.	Knowledge about the use of natural dyes in imparting UV protective finish	06 (20.00)	24 (24.0)
7.	Type of clothing used during summer seasons*		
	Cotton	26 (86.66)	-
	Silk	05 (16.66)	-
	Rayon	01(3.33)	-
	Polyester	-	-
	Nylon	-	-
8.	Type of clothing which provides maximum protection against UV radiation	04 (13.3)	26 (86.7)
	White colour cloths	27 (90.00)	-
	Dark colour cloths	02 (6.66)	-
	Both	01 (3.33)	-
9.	Type of fabric construction provides maximum protection against UV radiation		
	Woven	20 (66.7)	-
	Knitted	06 (20.0)	-
	Non-woven	03 (10.0)	-
	Any other	01 (3.30)	-
10.	Type of clothing/accessories used for protection of head from UV radiations*		
	Cap	08 (26.66)	-
	Hat	03 (10.00)	-
	Scarf	23 (76.66)	-
	Face mask	08 (26.66)	-
	Any other (Dupatta)	01 (3.33)	-
11.	Awareness about UV protective Scoodie	03 (10)	27 (90)

*multiple response

Selection of scoodie designs: Scoodie is carried as a fashion accessory with clothing. It is a combination of hood and scarf. This is often used by women and girls of different age groups. Total 16 scoodie designs were developed using CorelDraw software. Each design was developed using

different constructional as well as aesthetic features. The three top ranked scoodie designs was selected for the development of scoodie using standardized ultra-violet protective finished cotton fabric.



**Fig 1:** Developed Scoodie Designs

Preferential Choices for Scoodie Designs: Preferential choices of the respondents for scoodie designs to be developed. The data related to preferential choices of respondents for different scoodie designs are presented in Table 2.

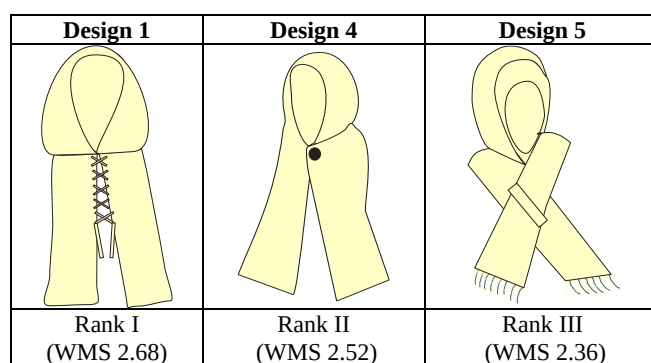
Table 2: Preferential choice for scoodie designs (n=30)

Designs No.	Weighted Mean Score (WMS)	Rank
1	2.68	I
2	1.96	X
3	2.13	VI
4	2.52	II
5	2.36	III
6	1.53	XVI
7	2.03	VII
8	2.26	IV
9	2.00	VIII
10	1.31	XV
11	2.16	V
12	1.43	XIV
13	1.82	XI
14	1.97	IX
15	1.63	XII
16	1.60	XIII

The data furnished in the table elucidate that as per the preferences of respondents design 1 scored the highest weighted mean score i.e. 2.68 and ranked 1 followed by design 4 (WMS 2.52) at rank II and design 5 ranked III

(WMS 2.36). the other designs preferred in decreasing order were design 8 (WMS 2.26), design 11(WMS 2.16), design 3 (WMS 2.13), design 7 (WMS 2.03), design 9 (WMS 2.00), design 14 (WMS 1.97), design 2 (WMS 1.96), design 13 (WMS1.82), design 15 (WMS 1.63), design 16 (WMS 1.60), design 12 (WMS 1.43) and design 10 (WMS1.31) whereas the design 16 was the least preferred design with WMS 1.60 and got the XVI rank.

It is thus inferred that *scoodie* design 1, 4 and 5 were selected for *scoodie* development using standardized ultra-violet finished cotton fabric.

**Fig 2:** Selected Designs for Scoodie Development

Development of Scoodie: The UV protective *scoodie* was prepared using ferrous sulphate-myrobalan mordanted curry leaves dyed cotton fabric. Paper patterns of *scoodie* were prepared for cutting and stitching of UV protective *scoodie*. The paper patterns and developed UV protective *scoodie* are shown in Figure 2 and 3 respectively.

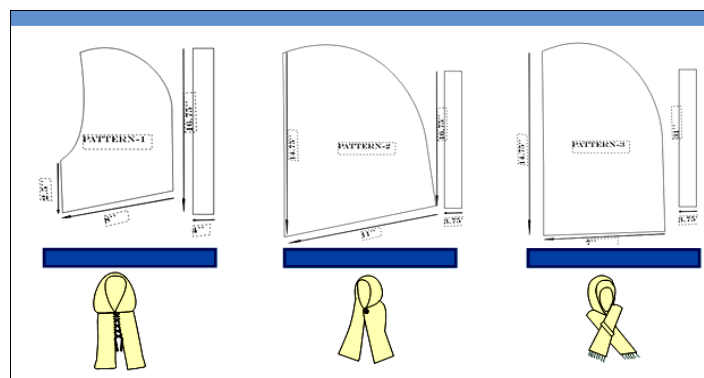


Fig 3: Paper Pattern of Developed UV Protective Scoodie

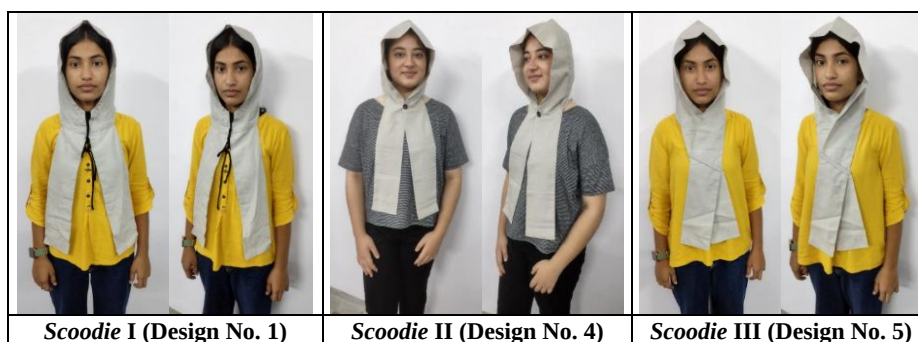


Fig 4: Developed UV Protective Scoodie

Assessment of consumer acceptance of developed UV protective scoodie: All the three designs of developed UV protective scoodie were displayed to the consumers and got assessed from 30 consumers. The consumers were mainly students and teachers of I.C. College of Community

Science. The opinions of consumers were recorded for appropriateness of constructional features of UV protective Scoodie. Majority of features incorporated in different UV protective scoodie designs are found suitable by the respondents as it is clearly evident from the Table 3.

Table 3: Assessment of respondents' perception towards developed UV protection scoodie=30

S. No.	Statements	Scoodie I (Design 1)		Scoodie II (Design 4)		Scoodie III (Design 5)	
		Yes F (%)	No F (%)	Yes F (%)	No F (%)	Yes F (%)	No F (%)
1.	Size and shape of developed Scoodie is aesthetically appealing.	28(93.3)	02 (6.66)	27 (90.0)	03 (10)	27 (90.0)	03 (10)
2.	Fabric used for the development of Scoodie is appropriate.	29(96.7)	01 (3.33)	29 (96.7)	01 (3.33)	29 (96.7)	01 (3.33)
3.	The constructional features used for the development of Scoodie are very good.	21(70.0)	09 (30)	29 (96.7)	01 (3.33)	29 (96.7)	01 (3.33)
4.	The developed scoodie is as per trend.	21(70.0)	09 (30)	21 (70.0)	09 (30)	22 (73.3)	08 (26.66)
5.	The developed UV protective Scoodie prepared using natural dye is appealing.	27 (90.0)	03 (10)	27 (90.0)	03 (10)	27 (90.0)	03 (10)
6.	The application of natural dye used for developing UV protective Scoodie is safe and environment friendly initiative.	29 (96.7)	01 (3.33)	29 (96.7)	01 (3.33)	29 (96.7)	01 (3.33)
7.	Use of natural dyes in dyeing of textile and finishing should be encouraged.	30 (100)	--	30 (100)	--	30 (100)	--
8.	The developed Scoodie is easy to wear and remove.	28 (93.3)	02 (6.66)	28 (93.3)	02 (6.66)	27 (90)	03 (10)
9.	The colour of developed UV protective scoodie is appropriate.	28 (93.3)	02 (6.66)	27 (90.0)	03 (10)	27 (90)	03 (10)
10.	One must wear Scoodie to get protect against UV radiations.	28 (93.3)	02 (6.66)	28 (93.3)	02 (6.66)	28 (93.3)	02 (6.66)
11.	I would like to purchase UV protective Scoodie.	29 (96.7)	01 (3.33)	28 (93.3)	02 (6.66)	29 (96.7)	01 (3.33)
12.	The developed UV protective Scoodie has good market potential.	28 (93.3)	02 (6.66)	28 (93.3)	02 (6.66)	30 (96.7)	--

Frequency=F, Percentage=%

Cost of developed products: Costing of UV protective *scoodie* was done on the basis of raw material and labour charges. Under the raw material cost of fabric, thread, embellishment and mordant was included. The cost of dye was not included in raw material as it was prepared from plant sources from the curry leaves which were collected

from the trees available in CCSHAU campus. It can be deduced from the Table 4 that the selling cost of UV protective *Scoodie* I (Design 1), *Scoodie* II (Design 4) and *Scoodie* III (Design 5) was Rs. 216/-, Rs. 198/- and Rs. 216/- respectively. The variation in price of developed UV protective *scoodie* designs is due to raw material cost.

Table 4: Cost of developed UV protective *scoodie* n=30

UV protective <i>scoodie</i>	Raw material (Rs.) (fabric, thread, mordant, energy, embellishment)	Labour charge (Rs.)	Cost of manufacturing (Rs.)	Selling price (Rs.) (including 20% profit)
<i>Scoodie</i> I (Design 1)	130	50	180	216
<i>Scoodie</i> II (Design 4)	115	50	165	198
<i>Scoodie</i> III (Design 5)	130	50	180	216

Assessment of respondents' opinion regarding cost of developed UV protective *scoodie*: The results related to assessment of different developed UV protective *scoodie* for market potential are presented in Table 5. The opinions of consumers were recorded for acceptability of cost of the

developed UV protective *scoodie* at which the developed UV protective *scoodie* could be sold. It can be inferred from the data in the table that the majority of consumers rated the highly appropriate for the cost of all the developed UV protective *scoodie*.

Table 5: Opinion of consumers regarding cost of developed UV protective *scoodie* n=30

UV protective <i>scoodie</i>	Cost (Rs.)	Highly appropriate	Appropriate	Somewhat appropriate	WMS
<i>Scoodie</i> I (Design 1)	216	12	14	04	2.26
<i>Scoodie</i> II (Design 4)	198	18	12	--	2.60
<i>Scoodie</i> III (Design 5)	216	20	08	02	2.60

Highly appropriate=3.00- 2.34, Appropriate=2.33-1.67, somewhat appropriate=1.66-1.00

4. Conclusion

Adequate sun protection and limiting UVR transmittance are associated with several known health benefits, including the prevention of life-threatening skin cancer. While a popular sun-protective method involves applying sunscreen, large amounts of sunscreen absorbed dermally have been found to cause detrimental neurotoxic, endocrine, and developmental defects. Photoprotective methods such as dyeing and laundering additives and UV protective textiles have emerged, with effectiveness in blocking UV rays as rated on the UPF scale. In the present study, it was found that the *scoodie* developed from Ferrous Sulphate - Myrobalan treated curry leaves dyed fabric is appreciated the consumers. It has the potential to protect the wearer from harmful UV radiations. It can be used in those areas such as farming where wearer exposed to UV radiations for long durations.

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