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Impact of Shellac and Gum Arabic in Shoe Polish Formulation based on Karanj Oil

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ABSTRACT

The study was conducted from August, 2021 to March, 2022 at the Department of Agricultural Engineering, Birsa Agricultural University, Kanke, Ranchi, Jharkhand, India to develop shoe polish based on Karanj oil and the impact of shellac and gum arabic in its formulation. The standardized composition of shoe polish was obtained as 3 part oil and one-part bee wax containing other elements like colour pigment, shellac, gum arabic and turpentine oil. To overcome the problem of colour, sixteen various combinations of shellac and gum arabic were carried out for improvement of colour in each case of black and brown polish. The developed shoe polish was tested for texture, applicability, spreadability, and ease in taking out the material. Colour was recorded with a gloss meter. The highest gloss meter reading i.e. 10.62 GU was recorded in the case of a black shoe polish containing shellac and gum arabic each weighing 0.75 g whereas a sample containing 1.25 g shellac and gum arabic each showed the lowest gloss reading of 3.88 GU. In the case of brown polish, the highest gloss meter reading i.e. 5.24 GU was recorded in the case of a sample containing shellac and gum arabic weighing 1.25 g each, and the lowest was observed in the case of the sample containing shellac weighing 0.5g and gum arabic weighing 0.75 g. Based on gloss value and sensory evaluation, the developed sample was found very near to standard brand shoe polish (Cherry) except that it gave an oily appearance initially.

KEYWORDS: Gum arabic, gloss unit, karanj oil, shellac, shoe polish

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1. INTRODUCTION

The primary function of shoe polish is to make the finished leather becomes smooth and glossy by gentle rubbing and also enhancing its performance and durability. **(**Turner, 1993**)**. Shoe polish is a mixture of paraffin wax with pigment, solvent (white spirit), turpentine oil, and nitrocellulose (Charles, 2019; Akinbomi et al., 2022)**.** Dyes and perfumes are sometimes added to the formulation. Shoe polish is applied to leather products to repel other solvents or dust from the film surface and impart elasticity and gloss to the film without destroying the hardness (Mohammed and Dawaki 2013). This should make the polish remains as discrete solid particles held mechanically within the leather.

Karanja (*Pongamia pinnata* L.) is a wild and largely neglected tree that grows unplanned but in abundance in several forested areas, in Jharkhand. From ancient days Karanj oil has been used in Jharkhand to light diya (small pot made of soil) during diwali festival. Annual production of Karanj seed in Jharkhand is 10,000 t per annum (Anonymous, 2023). It's seeds contain about 27–39% oil which may also be used as a lubricant, as illuminating oil, for tanning leather, as a water-paint binder, and for making soap and shoe polish (Kesari et al., 2013)**.** The oil is also known to have value in herbal medicine for the treatment of rheumatism, as well as human and animal skin diseases (Yadav et al., 2018 ; Bholane and Hiremath, 2020). Karanj seed meal, a by-product of the oil extraction process, can be used as a source of supplementary protein for the human diet, as a fertilizer, and as animal feed for ruminants and poultry (Sharma et al., 2020). All agricultural uses are not supported much in enhancing the value of the karanj oil price. The value addition of karanj oil is poor and results in low economic return to the producers.

Shellac is a long-chain polyester type of resin consisting of inter and intra-esters of polyhydroxy carboxylic acids where some acids are aliphatic long-chain hydroxy acids, and some are sesquiterpene acids (Wang et al., 1999). It is a natural product and is important due to its smooth, hard, and glossy film with high adherence so its many applications like Varnish, lacquer and polish formulations, adhesives, surface coating, ink, electrical industry, electrospinning and electrospray and in pharmaceuticals etc**.** (Liu et al., 2019; Du et al., 2019; Xue et al., 2019; Aravindakshan et al., 2021; Limmatvapirat et al., 2021).

Gum arabic acts as a natural product complex mixture of hydrophilic carbohydrate and hydrophobic protein components. The hydrophobic protein component functions as an emulsifier that adsorbs onto the surface of oil droplets while the hydrophilic carbohydrate component inhibits the flocculation and coalescence of molecules through electrostatic and steric repulsions in food additives (Anderson et al., 1990; Desplanques et al., 2012; Bai et al., 2016; Chivero et al., 2016; Gashua et al., 2016; Castel et al., 2017; Jin et al., 2017). Gum arabic is found in ink production, pottery pigments, and glazing for colour thickening in water-colours and paints, wax polishes, or for giving luster to silk and crepe in textiles and lithography (Wickens et al., 1995; Toure, 2008; Verbeken et al., 2003).

Jharkhand is naturally gifted with these products as a forest produce having low economic value. Therefore, there is a need to develop a product from these locally available materials namely karanj oil, shellac and gum arabic having high commercial value and hence high economic return to local people. Moreover, this is a maiden attempt to develop shoe polish based on Karanj oil incorporating shellac and gum arabic. Keeping the above facts in mind, an effort was made to develop shoe polish based on these products.

2. MATERIALS AND METHODS

The experiment was conducted at the Department of Agricultural Engineering, Birsa Agricultural University, Kanke, Ranchi, Jharkhand, India during August, 2021–March, 2022.

2.1. Oil extraction

Karanj seeds were procured from the local market of the Ranchi district. Clean and dried Karaj seeds were used for oil extraction by mechanical press method. The moisture content of fresh Karaj seeds was between 10–12% on a wet basis. Karanj seeds were subjected to pre-treatment before their oil extraction.

The feasibility of pre-treatment of oil seeds before oil extraction has been widely studied and has confirmed its efficiency in improving the oil extraction yield. In this experiment, conduction heating (roasting) was used as a pre-treatment method and oil extraction was carried out using an oil expeller (screw press). During the pre-treatment process of Karanj seeds, salt was used as a heating agent. Samples were kept in a stainless steel container and were heated using LPG Gas Stove. Salt was taken twice as compared to Karanj seeds weight and salt alone was heated initially up to 145°C, then Karanj seeds were mixed with heated salt and this mixture was allowed to come at respective operating temperatures (100°C, 105°C and 110°C) by adjusting the flame, at which heating experiments were conducted. The Roasting of Karaj seeds was carried out for 5 minutes for each temperature. Three kilograms of Karanj seeds were taken for each experiment. The temperature of salt and Karanj seeds, while heating/roasting, were measured using an Infrared thermometer. After heat treatment by roasting, Karanj seeds were subjected to oil extraction using an oil expeller. The extracted oil was filtered in a filtration unit and then filtered oil was kept in a container at room temperature for making shoe polish.

2.2. Shoe polish making process

The raw material used for making shoe polish were bee wax, Karanj oil, red/ brown oxide, Shellac mixture with spirit, Gum Arabic, Stirrer, Shoe polish container. First of all filtered oil was heated at 80°C for 5 minutes to make it odour free. The flow chart for making shoe polish is shown in Figure 1. First of all, in a double boiler, a lower vessel of the boiler was partially filled with water and then kept on the gas flame. The vapour formed during heating was used as a heat source for melting wax. The desired amount of bee wax was melted in the top vessel. After melting wax, oil was added. The oil and wax were mixed thoroughly by continuously stirring and when the mixture was homogeneous then the colour was added After adding the colour, the complete solution was stirred continuously for about 10 minutes to get a homogeneous mass and the temperature of the solution was kept between 85°C to 90°C by adjusting flame. To overcome the colour problem, a mixing of shellac and gum arabic was done. Different combination of shellac and gum arabic is shown Table 1. After colour mixing, the mixing of shellac was done. Gum arabic mixing was followed by shellac powder mixing. Finally, the mixture was poured into the empty plastic container and allowed to settle for one hour.

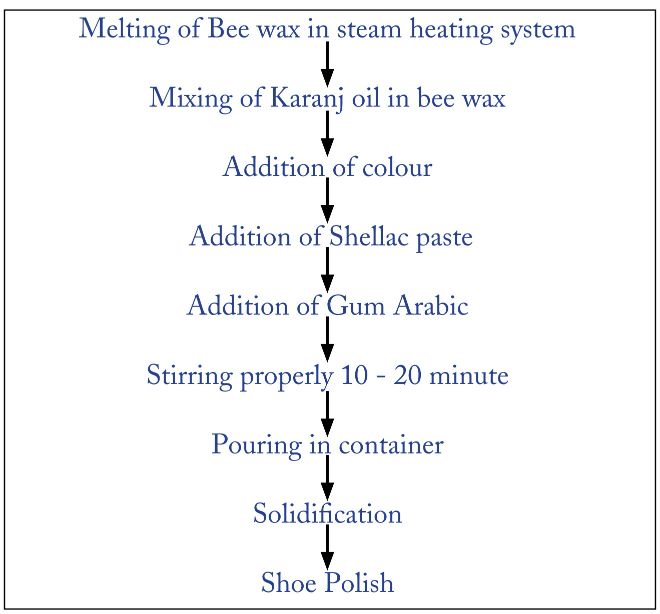

Figure 1: Flow chart of making shoe polish

2.3. Gloss meter reading

It is an instrument that is used to measure the specular reflection gloss of a surface. Gloss is determined by projecting a beam of light at a fixed intensity and angle onto a surface and measuring the amount of reflected light at an equal but opposite angle.

2.4. Sensory evaluation

Proforma for sensory evaluation were developed. Quality parameters like texture, spreadability, ease of taking out and colour were measured on a hedonic scale of 5. All parameters were compared with the cherry polish.

Table 1: Shoe polish made with 16 different combinations of shellac and gum arabic

Experiment No.	Shellac	Gum Arabic
1	0.5	0.5
2	0.5	0.75
3	0.5	1.0
4	0.5	1.25
5	0.75	0.5
6	0.75	0.75
7	0.75	1.0
8	0.75	1.25
9	1.0	0.5
10	1.0	0.75
11	1.0	1.0
12	1.0	1.25
13	1.25	0.5
14	1.25	0.75
15	1.25	1.0
16	1.25	1.25

Three trained panelists were selected out of five persons after initial trials based on the consistency of the result three panelists were selected and samples were evaluated according to the developed parameters on a scale of 1 to 5. The scale was developed keeping cherry polish as a standard sample having all the above-mentioned parameters on the highest side of sensory scores and the lowest scores were generated through the samples based generated during the oil and wax standardisation process.

Poor -1; Satisfactory-2; Good-3; Very Good-4; Excellent-5.

2.5. Statistical analysis

All the experiments were replicated thrice. The mean of the three values is presented here. Anova analysis was done through Microsoft Excel 2019.

3. RESULTS AND DISCUSSION

3.1. Oil extraction

After oil extraction, the data of oil yield was analysed and it was found that the oil extraction yield was minimum in the case of the control sample (oil extraction without pre-treatment). Oil extraction data is given in Table 2. It is obvious from the oil yield data that pre-treatment (roasting) of Karanj seeds caused a significant increase in the

Table 2: Percentage increment in oil yield (w.r.t. control sample) at various temperatures

Treatment	Sample weight (g)	Oil yield (g)	% increment in oil yield (w.r.t. control)
Control	3000	720	-
100°C	3000	815	13.19
105°C	3000	940	30.50
110°C	3000	1062	47.50

oil extraction yield obtained by the screw press. From the obtained data, it can also be concluded that the efficiency of oil extraction yield increased with increasing temperatures of the pre-treatment process. Oil yield was found to be 720 g, 815 g, 940 g and 1062 g for the control sample, 100°C, 105°C and 110°C roasted samples respectively. In the case of pre-treatment at 100°C temperature, the oil yield increased by 13.19% when compared to the control sample. Similarly, the percentage increment in oil yield for 105°C and 110°C was noted to be 30.50% and 47.50% respectively as compared to the control sample oil yield. This finding is consistent with the finding of Prasad et al., 2011. An increase in oil extraction yield is noticed in heat-treated seeds because heat treatment damages the cell of oil globules structure in oil seeds, reduces the viscosity of oil and hence facilitates the squeezing out of oils from its structure easily.

3.1. Evaluation of developed shoe polish

All developed samples of black and brown shoe polish were evaluated through a gloss meter and on a sensory basis.

3.1.1. Evaluation of Shoe polish based on gloss meter reading

The maximum gloss meter reading in the case of the black shoe was recorded in the case of experiment no.6 i.e. 10.62 GU and the minimum in experiment no. 16. i.e. 3.88 GU on the start day (Table 3). From Table 3, it is apparent that with each progressing day, the gloss unit showed an increasing trend till the end of the experiment i.e. 5 days. The highest mean value of the gloss meter was observed in the case of experiment number 5 i.e. 12.5 GU and the lowest in the case of sample number 16 i.e. 7.18 GU for black shoe polish. In the case of the brown sample, it showed an increasing trend up to four days after that its trend reversed (Table 3). The highest mean value of GU in the brown sample was observed in the case of experiment number 16 which is 5.14 GU and the lowest in the case of experiment number 1 i.e. 3.29 GU (Table 4). However, the control sample (cherry make) recorded a mean value of 3.77 GU. This is probably due to the polymeric reaction of shellac and gum arabic resulting in functional cross-linkable with other constituents having modified solid levels and increased retention of the constituents in mixed final solution (Mukhrerjee and Kumar, 1982; Cecil, 2005; Mandal and Nehete, 2016).

Table 3: Gloss meter reading of black shoe polish with varying date

Experi-ment No.	Day 1	Day 2	Day 3	Day 4	Day 5	Mean
1	4.36	7.08	7.14	8.28	9.71	7.31
2	10.02	10.72	11.11	10.94	13.62	11.28
3	7.5	8.84	9.45	9.46	12.13	9.47
4	7.17	8.81	9.14	9.57	11.58	9.26
5	9.94	12.4	12.42	12.66	15.2	12.52
6	10.62	11.83	12.31	13.49	13.66	12.38
7	10.32	11.91	12.21	12.52	15.54	12.5
8	8.53	10.65	11.29	11.91	13.43	11.16
9	7.05	10.34	10.97	11.17	14.05	10.71
10	8.29	10.67	11.46	11.99	15.55	11.59
11	8.8	10.27	10.85	11.63	14.35	11.18
12	7.08	9.34	10.23	10.85	13.25	10.15
13	8.85	11.37	11.38	12.03	12.75	11.27
14	5.25	7.58	9.06	9.67	11.21	8.55
15	6.33	9.49	10.71	9.63	13.22	9.87
16	3.88	6.73	7.29	7.92	10.1	7.18
Cherry	7.73	11.52	12.31	12.06	13.14	9.15
SEm±						0.40
CD (p=0.05)						1.42

3.1.2. Sensory evaluation

3.2.2.1. Black shoe polish

Various sensory parameters namely texture, spreadability, ease of taking out and colour were evaluated for 16 different experiments. Maximum texture value was obtained in the case of experiment no 4 i.e. 4 and minimum in experiments no 9 to 11 and 13 to 15 i.e. 2 (Table 5). In the case of spreadability, the maximum value was observed in

Table 4: Gloss reading meter of brown shoe polish with varying date

Experi-ment No.	Day 1	Day 2	Day 3	Day 4	Day 5	Mean
1	3.3	3.69	3.52	3.05	2.91	3.29
2	2.94	3.54	3.55	3.69	3.73	3.49
3	3.37	3.65	3.58	3.32	3.02	3.38
4	4.18	4.77	4.41	4.08	3.7	4.22
5	3.46	4.33	3.95	3.65	3.7	3.81
6	5.08	5.00	4.95	5.00	5.44	5.09
7	4.16	4.21	4.17	3.78	3.80	4.02

Table 4: Continue...

Experiment No.	Day 1	Day 2	Day 3	Day 4	Day 5	Mean
8	4.47	4.48	4.56	4.82	4.17	4.5
9	5.07	4.72	4.58	4.31	5.26	4.96
10	4.77	4.22	4.86	4.05	3.46	4.27
11	4.3	3.74	3.61	4.18	3.05	3.77
12	3.66	3.48	3.97	4.19	3.38	3.73
13	4.68	4.77	5.06	4.94	4.48	4.78
14	5.07	4.91	5.59	5.22	5.03	5.16
15	4.74	5.06	5.51	5.28	5.21	5.16
16	5.24	4.78	5.17	5.37	5.14	5.14
Cherry	3.23	3.85	4.19	3.73	3.85	3.77
SEm±						0.16
CD (p=0.05)						0.23

experiments no 2 and 5 and the minimum value in case of experiments no 4, 8, 10, 11 i.e. 3 whereas experiments no 2 and 16 recorded the highest value and the lowest value of ease in taking out the materials i.e. 4 and 2.66 respectively. Colours obtained in all the experiments were at par with colour of the cherry. A control sample was cherry and all attributes mentioned here were compared with the cherry polish. Out of 16 experiments, experiment no 2 performed well on all the parameters namely texture, spreadability, ease in taking out the matter and colour.

3.2.2.2. Brown shoe polish

The same set of 16 experiments (Table 5) varying shellac and gum arabic concentrations were evaluated in the case of Brown polish also. The good texture was observed in the case of experiment numbers 14 and 16 i.e. 4 on a hedonic scale of 5. Experiment number 13 and 16 recorded the highest value of spreadability which is 4 and the lowest was observed in the case of experiment number 2. The easiest taking out sample was experiment number 16 and experiment number 1 to 3 were the hardest in taking out the sample from the box. In general, due to the presence of oil on the surface, the recorded value of colour was less than the control Cherry sample. A very good colour was noticed in experiment number 16 and 13 i.e. 4 and satisfactory to near good colour was seen in the case of experiment number 3 i.e. 2.66.

On combining sensory evaluation and gloss meter reading, experiment no 2 and experiment 16 in the case of black and brown shoes respectively were considered as a final product.

Table 5: Sensory Evalaution of black shoe polish and brown shoe polish

Experiment No.	Black shoe polish				Brown shoe polish			
	Texture	Spreadibility	Ease in taking out the material	Colour	Texture	Spreadibility	Ease in taking out the material	Colour
1	3.33	3.33	3.33	5	3	3	3	3
2	4	4	4	5	2.66	2.66	3	3
3	2.66	3.33	3.33	5	3.33	3	3	2.66
4	2.33	3	2.66	5	3.33	3.33	3.33	3
5	3	4	3.33	5	3.66	3.66	3.66	3
6	3.66	3.66	2.66	5	2.66	3.33	3.66	3.66
7	2.66	3	3.66	5	3	3.66	3.66	3
8	2.66	3	3.33	5	3.33	3.33	3.66	3.33
9	2.66	3.33	3	5	3	3.33	3.66	3.66
10	2	3.33	3	5	3	3.66	3.66	3.33
11	2	3	3	5	3	3.66	3.33	3.33
12	2.33	3.66	3.66	5	4	3.66	3.33	3.66
13	3.33	3.66	3.66	5	3.33	4	3.33	4
14	2	3.33	3.66	5	3	3.66	3.66	3.66
15	2	3.33	3.66	5	3	3.33	3.66	3.66
16	2.33	4	4	5	4	4	4	4

4. CONCLUSION

The combined results of both subjective (sensory evaluation) and objective (gloss meter readings) assessments indicated that the sample containing 0.5 g of shellac and 0.75 g of gum arabic was suitable for use as the final product for black shoe polish. Similarly, the sample comprising 1.25 g of shellac and 1.25 g of gum arabic was found appropriate for brown shoe polish. Overall, these developed samples closely matched the quality and characteristics of a standard brand (Cherry) shoe polish in terms of gloss and sensory evaluation.

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