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Studies on the preparation of oleo-resinous wood varnishes by utilizing safflower (*Carthamus tinctorius*) seed oil

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Abstract

Studies were carried out on the preparation of oleo-resinous wood varnishes by utilizing safflower (*Carthamus tinctorius*) seed oil. It was observed that safflower seed grown under the soil-texture and climatic condition of Bangladesh, contains about 32 % golden yellow coloured drying oil. The physico-chemical characteristics of the oil were determined by the conventional methods and the fatty acid compositions by GLC. From the results it is evident that the oil can be used suitably in paint and varnishes on account of its high linoleic acid content (75 %) and higher iodine value (148). The oleoresinous wood varnishes was prepared by utilizing safflower seed oil in an open stainless steel beaker by heating the oil with rosin and glycerol. The cooking temperature was maintained at 300^{O} C for ½ an hour. Zinc oxide and lead oxide were used as mould growth inhibitor and catalyst respectively. The varnish thus prepared was found to be water resistant and can be applied on wood surface as tack free coating.

Introduction

Safflower (*Carthamus tinctorius*) is an erect annual herb with spinosely serrate leaves. It grows more or less in all over Bangladesh. But it grows well in the northern region of Bangladesh especially in the districts of Rajshahi, Natore and Chapai-Nawabgonj. The crop is generally cultivated as mixed crop with wheat, barley, gram or juar. The crop is drought and wind resistant. Its seed is reported to contain about 25-37 % golden yellow coloured fatty oils.[1] The oil possesses good drying properties and is suitable for making paint, varnishes, linoleum and other industrial products.[2] Pugsby and Winter[3] have reported that safflower oil dries as fast as linseed oil. Safflower seed oil is some what similar in comparison with linseed oil.[4] K. N. Ninan has reported the satisfactory use of safflower seed oil for the manufacture of paints, varnishes, linoleum, glass cement, fixing agent etc, on account of its good drying properties.[5] The oil shows good stability

in accelerated oxidation tests due to its high unsaturation.[6] Generally, linseed oil is a common drying oil mostly used in coating purposes. Safflower seed oil is such an oil which can substitute the linseed oil on account of its linoleic acid content and higher iodine value. Moreover, the presence of linoleic acid as a major component fatty acid in the oil gives an excellent non-yellowing and colour retention properties and makes the oil very suitable for the preparation of oleo-resinous wood vanishes and similar products. Most of the varnishes are manufactured by cooking the rosin with oil at elevated temperature with appropriate thinners.[7] The object of the present study is to prepare oleo-resinous wood varnishes by utilizing the safflower seed oil as tack free coating.

Materials and Methods

Safflower seeds were collected from three districts, namely Rajshahi, Natore and Chapi-Nawabgonj in the month of May-June. The seeds were cleaned and dried at a temperature 105^{O} C for an hour. The seeds were crushed into smaller particles in a mortar. The oil was then extracted by hydraulic press (22000 psi) and with n-Hexane in Soxhlet apparatus till the cake was free from the oil. The extracted solvent was removed by rotary vacuum evaporator under reduced pressure and calculated the percentage of oil. The specific gravity with the help of Pycnometer at 28^{O} C and refractive index using Abbe Refractometer at 25^{O} C were determined following IUPAC methods.[8] Moisture, volatile matter in the oil were also determined by IUPAC methods. The % of FFA, peroxide value, saponification value and unsaponifiable matter (%) were determined by the standard methods of AOCS.[9] Hanus method[10] was followed to determine the iodine value of the oil.

Analysis of fatty acids of safflower seed oil

The fatty acid composition of safflower seed oil was analysed as their methyl esters which was prepared by the Boron trifluride methanol (BF_3-CH_3OH) complex method.[11] A GCD Pye-Unicum type gas chromatograph equipped with a flame ionization detector was used to determine the fatty acid methyl esters. Nitrogen carrier gas was used at a flow rate of 30 ml/min. Fatty acids were separated on a 1.8 x $^1/_8$ i.d glass column packed with 6 % BDS (Butanediol succinate polyesters) on solid support Anakorm ABS (100/120) mesh. Analysis was carried out at isothermal column temperature 190^{O} C, injector and detector temperature for all GLC analysis were maintained at 230^{O} C. Gas chromatography peak were identified by comparison with standard methyl esters with respect to retention times against equivalent carbon length (ECL), peak areas were measured by a Pye-Unicum electronic integrator.

The percentage of each peak was calculated as the total area of all the peaks.

Preparation of oleo-resinous wood varnishes

100 g. of rosin was taken in a stainless steel beaker and heated to 130^{O} C. A portion about 10 % of the total quantities of safflower oil (100 g.) was added with it and the temperature raised to 200^{O} C. Zinc oxide (1g.) and glycerol (8 g.) were added slowly keeping the temperature 250^{O} C for about ½ an hour. Rest of the oil was gradually added while maintaining the same temperature. Finally lead oxide (l g.) was added as a catalyst and the temperature of the mass raised to 300^{O} C. The temperature was kept constant for ½ an hour and then the sample was drawn at regular intervals for test. The varnish was evaluated as follows:

1. Drying properties by touching with finger after application.
2. Noting the time taken for the film to touch dry, hard dry and tack-free.
3. Water resistance by immersed in water.

Results and Discussion

The physico-chemical characteristics of the safflower seed oil were determined by the conventional methods and the results are given in Table I. From Table I, it is observed that no significant difference in physical and chemical properties among the three samples collected from three districts. Only iodine values indicated that the amount of unsaturated fatty acids are more or less in good agreement with the result of Wizs.[12] The fatty

Table I. Physico-chemical characteristics of safflower seed oil

Constituents / Properties	Location		
	Rajshahi	Natore	Chapi-Nawabganj
% of oil (Solvent extraction)	32.0	31.81	30.97
Moisture and volatile matter (%)	0.125	0.127	0.130
Melting point	30-31^{O} C	30-31^{O} C	29.5-30.9^{O} C
Specific gravity at 28^{O} C	0.9210	0.9213	0.9215
Refractive index at 25^{O} C	1.4735	1.4733	1.4738
% FFA	1.30	1.31	1.30
Peroxide value (M.eqO_2/ Kg. Oil)	2.27	2.24	2.26
Saponification value	190	189	189
Unsaponifiable matter (%)	1.25	1.28	1.28
Iodine value	148	148	147

Mean value of three experimental results.

acid composition safflower seed oil was analysed by GLC and the results are presented in Table II. From the Table II, it is showed that the fatty acids present in the oil are mainly linoleic (75 %), oleic (12.6 %), palmitic acid (8.4 %), stearic acid (2.6 %) and myristic acid (1.4 %).

From the Table I and II, the iodine value and linoleic acid content of the oil were found to be high and these properties of the oil makes the oil very suitable for the preparation of oleo-resinous wood varnishes. The time taken for the films to touch dry, hard dry and tack free are presented in Table-III and the results reveled that the drying properties of the oleo-resinous wood varnish is satisfactory using zinc oxide and lead oxide were used as mould growth inhibitor and catalyst

Table II. Fatty acid composition of safflower seed oil (Wt. %)

Fatty acid	Location		
	Rajshahi	Natore	Chapai-Nawabganj
Linoleic acid	75.0	75.0	74.8
Oleic acid	12.6	12.5	12.8
Palmitic acid	8.4	8.4	8.3
Stearic acid	2.6	2.7	2.6
Myrestic acid	1.4	1.4	1.5

Table III. Drying time (in hour) of oleo-resinous wood varnishes films of safflower seed oil

Location	% of oxide by the wt. of oil	Time taken in hour for film to		
		Touch dry	Hard dry	Tack free
Rajshahi	ZnO - 1.0	1 - 2	4 - 5	24
	PbO - 0.50	1 - 2	4 - 5	
Natore	ZnO - 1.0	1 - 2	4 - 5	23
	PbO - 0.50	1 - 2	4 - 5	
Chapai-Nawabganj	ZnO - 1.0	1 - 2	4 - 5.5	24
	PbO - 0.50	1 - 2	4 - 5.5	

Table IV. Water resistance properties of oleo-resinous varnish of safflower seed oil

Location	Oleo-resinous varnish	Time for				
		1 hour	2 hours	4 hours	6 hours	24 hours
Rajshahi	,,	No effect	No effect	No effect	No effect	No effect
Natore	,,	No effect	No effect	No effect	No effect	No effect
Chapai-Nawabganj	,,	No effect	No effect	No effect	No effect	No effect

respectively. The prepared varnish was applied on wood surface at 0.005″ thickness, air dried for 3 days and then immersed in water. The wooden surfaces were examined at various intervals of times such as 1, 2, 4, 6 and 24 hours for appearance which are given in Table IV. From the Table IV, it is found that there is no effect on appearance among the three samples collected in three different locations.

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