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Bauhinia roxburghiana Voigt and *Aphanamixis polystachya* (Wall.) Parker: Potential Non-Edible Oil Resources for Future Energy

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The present study describes the preliminary work of seeds of *Bauhinia roxburghiana* Voigt (BR) (Synonym-*Bauhinia semla* Wundrlin and *Bauhinia retusa* Roxb.) belongs to family Caesalpiniaceae and *Aphanamixis polystachya* (Wall.) Parker (AP) belongs to family-Meliaceae. Seeds of both species were studied for physico-chemical properties such as- oil content, ash content, moisture content, acid value, saponification value, iodine value, specific gravity, refractive index, free fatty acids, mean molecular mass by standard methods and fatty acid by gas chromatography. Oil was extracted with petroleum ether (60-80 ° C) in a Soxhlet apparatus. Total protein in seed and nitrogen content was carried out with Kjeldhals method. The results were compared with some common vegetable oils to search as a potential source in seeds of two species for future energy.

Key Words: Extraction, Seed oil, Physico-chemical properties, Fatty acid composition.

INTRODUCTION

In India, there are more than 100 varieties of non-edible oil seeds available in the wild state. There is a need to search regionally suitable non-edible oil resources that have good oil content. Western Maharashtra is known for traditional non-edible oil resources like *Madhuca longifolia* Macb., *Hydnocarpus laurifolia* Sleumer, Mesua *ferrea* L., *Scheilchera oleosa* Oken, *etc.*[1]. During present research work on "Germplasm collection of non-edible oil sources from western Maharashtra", we came across some seed oils of different plants which will be used as alternative sources for future energy. According to various field surveys carried out in Maharashtra and adjoining areas for *Bauhinia roxburghiana* Voigt (BR) (Synonym-*Bauhinia semla* Wundrlin and *Bauhinia retusa* Roxb.) has been reported from Chandrapur and Marathwada regions in open forests[2,3]. Few trees are also grown in gardens for its beautiful flowers. Research work have been carried out on seed and seed oil of *Bauhinia racemosa*, *Bauhinia varigata*, *Bauhinia malabarica* and *Bauhinia purpurea* for their oil content variation and fatty acid composition[4-7]. *Aphanamixis polystachya* (Wall.) Parker is an evergreen tree. It is found in Maharashtra in wild as well as cultivated in gardens for ornamental purpose[2]. Seeds of *Bauhinia roxburghiana* Voigt (BR) and *Aphanamixis polystachya* (Wall.) Parker

(AP) have not been studied for their oil content and chemical composition. While considering it for future energy it was compared with commonly available seed oils like *Jatropha curcas* (JC), *Madhuca indica* (MI) and *Glycine max* (GM).

EXPERIMENTAL

Seed samples: Well dried and matured fruits were collected from Pune, India during appropriate season. Seeds were dried under shade for few days.

Extraction of oil from seeds: The seeds were crushed in a grinder machine at 37 °C for few minutes. Oil was extracted with petroleum ether (60-80 ºC) in a Soxhlet apparatus for 6 h. Solvent was removed under reduced temperature and pressure. The yield of oil was calculated using single sample with three replicates.

Physico-chemical properties: The iodine value (IV), saponification value (SV) and acid value (AV) of the oil were determined by standard procedures described in the literature[8,9]. The mean molecular mass (MMM) was estimated from the equation (560/SV) × 100[9-11]. The free fatty acids (FFA) was calculated from the relationship given *i.e.*, 1 unit of acid value ≠ 0.503 % FFA (calculated as oleic acid)[11]. The specific gravity was determined by the method[12]. Refractive index was carried out by refractometer at 20 ºC (Erma Tokyo no. 6343) Table-1. Crude nitrogen was determined by Kjeldhals method and protein was calculated by N × 6.25[13]. Ash content was carried out in muffle furnace at 560 ºC and moisture content by sartorius MA 45 autoanalyzer at 100 ºC.

TABLE-1
CHEMICAL PROPERTIES OF SEED OIL OF *Bauhinia roxburghiana* AND *Aphanamixis polystachya* COMPARE WITH SOME MOST COMMON OILS

Properties	BR	AP	MI[20]	JC[16]	GM[21]
Oil color	Yellowish brown	Brown	–	–	–
Oil content (% fat)	30.39	36.94	40.0	40.0	–
Moisture %	5.01	7.64	Trace	5.54	–
Ash (%)	0.96	0.95	0.006	–	–
Specific gravity at RT (28 °C)	0.913	0.925	0.904	–	0.936
Refractive index (20 ºC)	1.48	1.48	1.45-1.46	–	1.46
Acid value (mg/g)	2.72	5.89	–	–	6.2
Iodine value (g/100 g)	272.9	137.5	55-70	93.0	120-135
Free fatty acids (mg/g)	1.34	0.60	–	–	–
Saponification value (mg KOH/g)	321.7	351.1	187-197	202.6	192
Mean molecular mass	174.1	159.51	–	–	–
Nitrogen %	6.06	2.33	–	3.2–4.44	–
Protein %	38.33	14.62	–	24.60	–

BR = *Bauhinia roxburghiana* Voigt; AP = *Aphanamixis polystachya* (Wall.) Parker
MI = *Madhuca indica*; JC = *Jatropha curcas*; GM = *Glycine max.*

Seed powders were used for determination of fatty acids[14]. The fatty acid was estimated on Agilent 6890 N gas chromatograph with auto sampler and auto injector. The samples were injected in 30 mm long, 0.32 mm diameter HP-Innovax Capillary

Column. Auto injector, oven temperature and flame ionization detector were adjusted to 225, 115 and 275 °C, respectively. The initial oven temperature was 150 °C ramped by 15 °C/min up to 250 °C/min. Flame ionization detector (FID) was used to detect the signals. Hydrogen and air with flow rates of 30 and 400 mL/min, respectively, were used to ignite the flame of FID. Nitrogen gas (2 m L/min) was used as carrier gas. Standard fatty acids of Sigma Chemicals Ltd., were used as standard to calibrate the method. The signals from the detector were integrated as normal percentages of calibration curve by using HP chemstation software.

RESULTS AND DISCUSSION

Seed oil obtained from *Bauhinia roxburghiana* Voigt (BR) and *Aphanamixis polystachya* (Wall.) Parker (AP) is yellowish brown and brown in colour and remains in non-drying state at room temperature[15,16] and physico-chemical characters are reported in Table-1. The content of oil in BR and AP were found to be high, ranging up to 30.39 and 36.94 % by weight of the seeds, respectively. This value is close to those obtained from the other common oil-bearing seeds. Oil percentages in other species of *Bauhinia variegata* is 15-16.55 %[17,18]. In case of *Bauhinia variegata* and *Bauhinia malabarica* seed oil contain 16 %. Moisture content in BR and AP is 5.01 and 7.64 % which lies within the range of *Jatropha curcas*. Ash values are 0.96 and 0.95 %, respectively and were slightly higher than the *Madhuca indica*.

Specific gravity of *Bauhinia roxburghiana* Voigt (BR) and *Aphanamixis polystachya* (Wall.) Parker (AP) is determined by specific gravity bottle and it is found to be 0.931 and 0.925 at 28 °C. These values are comparable with value of most of the seed oils. Refractive index of BR and AP oil is determined by Erma Tokyo no. 6343 refractometer at 20 ºC and it is found to be 1.48 in both. These values are slightly higher than the most of seed oils.

The acid value of *Bauhinia roxburghiana* Voigt (BR) and *Aphanamixis polystachya* (Wall.) Parker (AP) oil is found to be 2.72 and 5.89 mg KOH/g. These values are slightly less than the reported seed oils. AV up to 6.2 mg KOH/g^{-1} is suitable for *trans*-esterification[19]. The iodine value of BR and AP is found to be in the range 272.9 and 137.5 g/100 g, respectively. The iodine value of most of the vegetable oils was observed within the range 104-132 g/100 g[20].

The vegetable oil from fresh seeds contains only fewer amounts of free fatty acids but their quantity increases due to hydrolytic changes. Thus, they impart a sharp and unpleasant flavour to edible oils[22]. It is observed that BR and AP seed oils free fatty acids are 1.34 and 0.60 mg/g.

The SV of BR and AP oil is found to be 321.7 and 351.1 mg KOH/g, respectively. These values are high as compared to other vegetable seed oil. Specific gravity ranges of common vegetable oils are found to be approximately 190-196 mg KOH/g. Mean molar mass of BR and AP oil is found to be 174.1 and 159.51, respectively.

Nitrogen content of BR and AP is 6.06 and 2.33, respectively. These values are comparable with other seed oils. Protein content of BR and AP is 38.33 and 14.62,

respectively. These values lie within the range of other vegetable seed oils. Total protein content in *Bauhinia variegata* and *Bauhinia malabarica* are 41 and 25 %[7].

Compositions of the fatty acid (FA) esters are given in Table-2. The fatty acid profile present in the mixture is identified by comparison against the standard fatty acid esters. Total saturated fatty acid (SFA) content in BR and AP are 289.1 and 267.3 mg/g whereas, unsaturated fatty acid (UFA) are 710.8 and 737.0 mg/g. The palmitic acid content in BR is 18.58 %, higher than the AP 12.0 %. In comparison with *Madhuca indica*, it is higher 24.5 % and lower in *Jatropha curcas* and *Glycine max*. The stearic acid content in BR and AP is 10.33 and 14.73 %, respectively. These values are lower in *Madhuca indica* and higher in *Jatropha curcas* and *Glycine max*. Oleic acid content is 26.11 and 28.78 %. As compared to other seed oils it is less than the *Madhuca indica*, *Jatropha curcas* and *Glycine max*. Linoleic acid is 44.97 % in BR, which is higher than all other vegetable oils *i.e.* AP (22.18 %), *Madhuca indica* (14.3 %), *Jatropha curcas* (32.1 %) and lower than *Glycine max* (36.6-61.1 %). Linolenic acid is absent in BR, while 22.28 % in AP and is higher in *Glycine max*. Arachidic acid is absent in all except *Jatropha curcas*. Fatty acids determined by gas chromatography showed that it is highly unsaturated oil1[9]. Based on the present investigation and analytical profile of *Bauhinia roxburghiana* Voigt (BR) and *Aphanamixis polystachya* (Wall.) Parker (AP). Seed oil of both species is suitable for potential energy purposes.

TABLE-2
FATTY ACID COMPOSITION OF BR AND AP COMPARE WITH MI[21], JC[16] AND GM[23]

Fatty acid (%)	Formula	Structure	BR	AP	MI	JC	GM
Myristic acid	$C_{14}H_{28}O_2$	14:0	–	–	–	1.4	–
Palmitic acid	$C_{16}H_{32}O_2$	16:0	18.58	12.00	24.5	15.6	10-15.5
Stearic acid	$C_{18}H_{36}O_2$	18:0	10.33	14.73	22.7	9.7	1.6-4.1
Oleic acid	$C_{18}H_{34}O_2$	18:1	26.11	28.78	37.0	40.8	14.2-44.3
Linoleic acid	$C_{18}H_{32}O_2$	18:2	44.97	22.18	14.3	32.1	36.6-61.1
Linolenic	$C_{18}H_{30}O_2$	18:3	–	22.28	–	–	8.2
Arachidic acid	$C_{20}H_{40}O_2$	20:0	–	–	–	0.4	–

BR = *Bauhinia roxburghiana* Voigt; AP = *Aphanamixis polystachya* (Wall.) Parker
MI = *Madhuca indica*; JC = *Jatropha curcas*; GM = *Glycine max.*

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