Physico-Chemical Studies of Seed Oil of *Prinsepia utilis* Royle (bhekal) Grown in Chakrata Region and Its Comparison With Conventional Food Oils

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Abstract-Oil and fats are important component of human dietary system. Increase in demand and different applications of oil foster the search for vegetable and seed oil of high quality. In India several regions have developed specific preference for edible oil locally available. Several pockets in Garhwal Himalayan region, people give preference to some wildly growing species. *Prinsepia utilis* (bhekal) is one of that kind. This paper deals with the investigation of physicochemical characteristics, fatty acids composition and mineral content seed oil of bhekal (*P. utilis*). Mature seeds were collected from Chakrata forest division, Chakrata, Uttarakhand, India and oil was extracted by conventional method. Extracted oil was yellow in colour, tasteless, odour less, soluble in benzene, pet-ether and slightly soluble in acetone. Its physico-chemical and proximate values were determined by appropriate lab method. The elements present in seed oil were also determined which reflect that oil is rich in Iron, Sodium, Potassium and appropriate range of Potassium, Zinc, Calcium and Magnesium which make it suitable for edible consumption and commercial purposes. The composition of fatty oil was determined by Gas Chromatography (GCMS). From GCMS analysis the main constituents of oil such as Myristic acid (13.10%), Palmitic acid (10.20%), Stearic acid (21.90%) and Oleic acid (4.50%) were determined. Nutritional and physico-chemical properties of the *Prinsepia utilis* oil and their comparison with other food grade oil suggested that oil is suitable for use in domestic and for the industrial uses.

Keywords: *Prinsepia utilis*, Edible oil, Proximate value, Fatty acid composition, Mineral content.

Introduction

A variety of plants produce their reserve food in the form of oil which stored either in seed or in their fruit. The seed that contain oils are called "oil seeds" and these oil seeds are receiving growing interest due to their high concentration of bioactive lipid components which have shown various health benefits and constantly consumed in most developing and under developed countries by both man and animals. A number of seed oils have been characterized for the identification of several fatty acids of nutritional and nutraceutical importance but the vast majority have not been adequately evaluated. Increase in demand and different applications of oil foster the search for vegetable and seed oil of high quality such as *Prinsepia utilis*. Royle (Family Rosaceae) seed. It is commonly known as Bhekal, Bekhali, Bekoi, Jhatlu etc. It is a moderate sized underutilized deciduous shrub widely distributed in Himalayas at 1000 - 3000 msl., occurring frequently in open, sunny and dry places. Flowers season is from the month of December-January, while fruit ripining occurs during the month of April and June. Fruit are single seeded, oblong in shape and have fleshy edible Mesocarp. Bhekal seed oil is preferably used in remote areas of Garhwal Himalayan but very scanty information is available on its proximate values and on the fatty acid compositions.

Material and Methods

Collection of plant material and extraction of oil

Fully mature fruit of *P.utilis* were collected during the month of May-June from Chakrata Forest Division, Uttarakhand, India which is at an altitude of 2700 m ($30^0$37'00.25" N, $77^0$52'28.09" E). The plant was identified by the Taxonomist at systematic Borany Division, Forest Research Institute, Dehradun, India. A voucher specimen has been deposited and received Accession no. 172708. The collected seeds were dried and grounded to powdered via using a mechanical grinder after the removal of seed coat (AOCS, 2001). The fatty oil was extracted with petroleum ether solvent (b.p. 40-60 $^{\circ}$C) by using soxhlet apparatus.

Determination of Physio-chemical properties of seed oil

The fatty oil was accessed for the determination of proximate and physicochemical properties. Seed oil colour, taste, smell, sedimentation, physical state at normal room temperature were subject of general observation, whereas refractive index was determined at 25°C with Abbey Refractometer. The seed oil was assessed for various physico-chemical properties. Standard methods described by Association of Official Analytical Chemists (AOAC,1990) were used for the determination of yield per cent, moisture content, ash, crude fibre and free fatty acids (FFA) contents of the fatty oil. Iodine value was determined by Wij's method (AOAC, 1990). Saponification values, unsaponifiable matter content and acid value of the oil sample was determined by the procedures of Egan *et al*. (1981). Per cent Protein was determined using micro-Kjeldhal method as adopted by Allen and Quarmby (1989). Carbohydrate content was determined by colorimetric method described by Allen and Quarmby, 1989

Determination of mineral content of oil

The metal composition Zinc, Iron, Copper of theoil were determined by using an Atomic Absorption Spectrophotometer (Model Varian AT2049/France), after acid digestion. Total calcium and magnesium were determined by complexometric titration with 0.1M EDTA, by using blue dye Erichome Black T (Erio T) was used as indicator and calculated. Phosphorus was determined by the precipitation of phosphorus in the form of phosphomolybdate by using the reagent ammonium molybdate. Precipitate was filtered from asbestos, then residue obtained was taken in conical flask and dissolved in 0.1M NaOH and titrate with 0.1M HCl by using indicator Phenolphthalein. Sodium and potassium were determined by flame photometer.

Determination of fatty acid composition of oil by GC-MS

Fatty acid composition of fatty oil was determined by Gas Chromatography and Mass spectrophotometer. 0.2g of oil sample were weighed into 250ml conical flask and methylated with 6ml of sodium methyloxide.

Results and Discussion

The results obtained in the present study quantified the physico-chemical properties, mineral content and fatty acids composition of bhekal seed oil. The results obtained are given in tables under each of its respective topics as follows.

Determination of physico-chemical and proximate value of oil

Physico-chemical properties were determined by following standard methods. The oil extracted from bhekal is yellow in color, having pleasant odour, tasteless and liquid at room temperature (25±5 °C) but below normal room temperature it is semi-liquid or get solidified in its crude state. The fatty oil yield was 51.00% with very low amount of moisture percentage (1.20%) which is free from sedimentation. Data of all physico-chemical properties are being given in table -1.

Table-1 Physico-chemical properties of *P. utilis* seed oil.

S. No.	Physico -chemical properties	Results
1	Colour	Pale yellow
2	Taste	Neutral, free from bitter and after test
3	Smell	Pleasant
4	Sedimentation	Free from sedimentation
5	State at room temperature	Liquid
6	Refractive index (at 25 ^{o}C)	1.36
7	Specific gravity (g/cm^{3})	0.84
8	Yield (%)	51
9	Moisture (%)	1.20
10	Protein (%)	0
11	Fiber (%)	0
12	Carbohydrate (%)	0
13	Acid value (mg/KOH/g)	3.97
14	Iodine value	142
15	Saponification values (mgKOH/g)	220
16	Unsaponifiable matter (%w/w)	0.02
17	Free fatty acid (%)	13.90
18	Total saturated (%)	21.80
19	Total unsaturated (%)	34.60

Determination of mineral content of Bhekal oil

The level of phosphorus, calcium, magnesium, sodium, potassium and manganese were found in good amount in seed oil, while the oil has much lower amount of iron, copper and zinc (Table-2) fall within the range of values obtained for some vegetable oils.

Table-2 Mineral content seed oil (mg/100g) of *P. Utilis*

S. No	**Parameters**	**Results** (mg/100g)
1	Phosphorus	428
2	Calcium	312
3	Magnesium	3.21
4	Sodium	0.48
5	Potassium	1.02
6	Iron	3.90
7	Copper	1.32
8	Zinc	3.19

Determination of composition of bhekal oil by GC-MS

GC-MS analysis of fatty acids showed that the main constituents of oil is Myristic acid, Palmitic acid, Stearic acid and Oleic acid (Table-3).

Table-3 Fatty acid composition of *P. utilis* seed oil(mg/100g)

S. No	**Parameters**	**Results**
1	Myristic acid	13.10
2	Palmitic acid	10.20
3	Stearic acid	21.90
4	Oleic acid	4.50

A comparison of bhekal oil properties was also done with the previously reported properties of some conventionally used oils (CUOs), for food and other purposes by Gopalan et al., 1971; Anonymous, 2001 and Bachheti et al,2015. Bhekal oil is existing in liquid state at room temperature as all other CUOs but it gets solidified or in semi-solid status at below room temperature as coconut oil. The physical colour of bhekal oil is also in colour range of CUOs which varies from colorless, yellow to dark brown. The proximate chemical composition and physical attributes of the nine different CUOs and bhekal oil are given in Table-4 and Table-5.

Table-4 Proximate composition of some conventional oil and bhekal oil

Species	**Moisture (%)**	**Yield (%)**	**Protein (%)**	**Fibre (%)**	**Carbohydrate (%)**
Soybean oil (*Sojamax*)	8.1	19.5	43.1	3.7	20.9
Mustard seed oil (*Brassica compestris*)	8.5	39.7	20.0	1.8	23.8
Ground nut oil (*Arachis hypogoes*)	3.0	40.1	25.3	3.1	26.1
Cotton seed oil (*Gossypium*)	9.9	19.5	19.4	22.6	23.9
Linseed oil (*Linum usitatissium*)	6.5	37.1	20.3	4.8	28.9
Sunflower oil (*Helianthus annus*)	5.5	52.1	19.8	1.0	17.9
Coconut oil (*Cocos mucifera*)	4.2	39.0	23.9	10.9	17.1
Almond seed oil (*Prunus arnygdalyus*)	5.2	58.9	20.8	1.7	10.5
Wild apricot (*Prunus armeniaca*)	6.8	44.3	31.8	1.94	15.6
Bhekal (*Prinsepia utilis*)	**1.0**	**51.0**	**0.0**	**0.0**	**0.0**

Table-5 Physical attributes of some conventional seed oil and bhekal oil

Species	State at room temperature	Colour	Refractive index (40 ^{o}C)	Specific gravity at 25 ^{o}C
Soybean oil (*Sojamax*)	Liquid	Yellow	1.46	0.91
Mustard seed oil (*Brassica compestris*)	Liquid	Brownish yellow	1.46	0.90
Ground nut oil (*Arachis hypogoes*)	Semi solid	Colour less	1.46	0.91
Cotton seed oil (*Gossypium*)	Liquid	Yellow	1.46	0.91
Linseed oil (*Linumusitatissium*)	Liquid	Colour less	1.47	0.93
Sunflower oil (*Helianthus annus*)	Liquid	Pale yellow	1.46	0.91
Coconut oil (*Cocosnucifera*)	Semi liquid	Colour less	1.44	0.91
Almond seed oil (*Prunus arnygdalyus*)	Liquid	Pale yellow	1.46	0.91
Wild apricot (*Prunus armeniaca*)	Liquid	Pale yellow	1.46	0.91
Bhekal (*Prinsepia utilis*)	**Liquid**	**Yellow**	**1.36**	**0.84**

The chemical properties of oil are among the most important properties that determine the present condition of oil (Nzikouet al., 2009). Among these oils, yield of kernel is similar to the oil yield of almond oil (58.9%) and sunflower oil(52.1%) as reported by Bachheti et al., 2012, and higher than that of many conventional oil seed crops like cotton (15.0-24.0%), soybean (17.0-21.0%) reported by Pritchard,1991, Mustard seed oil (39.7%), ground nut seed oil (40%), linseed oil (37.1), coconut seed oil (39.0%) and wild apricot (44.3%). In the agricultural economy of India, oilseeds are important next only to food grains in terms of production and value. In view of the increasing demand of edible oil, government of India is promoting nonconventional source of edible oil which would give high per unit area production (Motilal, 1996). This high percentage oil yield of bhekal in this study show that the industrial processing of the oil for soap making and edible purposes would be viable.

The acid value of bhekal oil is found 3.78mg/KOH/g is nearest to linseed oil, sunflower seed oil, ground nut oil, coconut oil, almond and apricot seed oil which is already in use for edible purposes and this fall within the recommended codex of 0.6 and 10 for virgin and non-virgin edible fats and oils respectively (Dawodu, 2009). Aremu et al., 2015 and Akubor et al., 2008, also reported that low acid value in oil indicates that the oil will be stable over a long period of time and protect against rancidity and peroxidation. This essence suggests that the bhekal oil is suitable for edible purposes and also in the

manufacture of paints and varnishes (table-6). The iodine value of bhekal oil was found 142 g/100g; indicates the degree of saturation of oil. Aremu et al. (2006a) reported that the lower the iodine value, the lesser the number of unsaturated bonds; thus, the lower the susceptibility of such oil to oxidative rancidity. The saponification value of bhekal oil is 220 mg/KOH/g and it falls within the range of values obtained for some vegetable oil 188 - 235mgKOH/g (Aremu et al., 2006).(Motilal, 1996). This high percentage oil yield of bhekal in this study show that the industrial processing of the oil for soap making and edible purposes would be viable. The acid value of bhekal oil is found 3.78mg/KOH/g is nearest to linseed oil, sunflower seed oil, ground nut oil, coconut oil, almond and apricot seed oil which is already in use for edible purposes and this fall within the recommended codex of 0.6 and 10 for virgin and non-virgin edible fats and oils respectively (Dawodu, 2009). Aremu et al., 2015 and Akubor et al., 2008, also reported that low acid value in oil indicates that the oil will be stable over a long period of time and protect against rancidity and peroxidation. This essence suggests that the bhekal oil is suitable for edible purposes and also in the manufacture of paints and varnishes (table-6). The iodine value of bhekal oil was found 142 g/100g; indicates the degree of saturation of oil. Aremu et al. (2006a) reported that the lower the iodine value, the lesser the number of unsaturated bonds; thus, the lower the susceptibility of such oil to oxidative rancidity. The saponification value of bhekal oil is 220 mg/KOH/g and it falls within the range of values obtained for some vegetable oil 188 - 235mgKOH/g (Aremu et al., 2006).

Table-6 Chemical properties of some common edible oils and bhekal oil

Species	**AV** [a]	**IV** [b]	**UM** [c]	**SV** [d]	**FFA** [e]	**TS** [f]	**TU** [g]
Soya been oil (*Sojamax*)	1.08	132.0	0.33	192	0.56	14.39	85.66
Mustard seed oil (*Brassica compestris*)	1.21	108.0	0.35	174	0.59	8.79	91.21
Ground nut oil (*Arachis hypogoes*)	3.98	88.0	0.62	193	1.74	13.11	81.89
Cotton seed oil (*Gossium*)	0.26	108.0	0.86	195	0.10	22.56	77.4
Linseed oil (*Linum usitatissum*)	3.42	174.0	1.09	189	1.61	10.54	89.46
Sunflower Seed oil (*Helianthus annus*)	3.89	128.0	0.96	188	1.68	9.63	90.37
Coconut oil (*Cocos nucifera*)	3.62	8.4	0.43	261	1.79	92.68	8.92
Almond seed oil (*Prunus arnygdalys*)	3.42	96.0	0.49	191	1.72	9.0	86.0
Wild apricot seed (*Prunus armenica L*.)	4.05	102.0	0.71	190	2.01	7.17	93.13
Bhekal seed oil (*Prinsepia utilis*)	**3.78**	**142**	**0.02**	**222**	**13.90**	**21.80**	**34.60**

a: Acid value, b: Iodine value, c: Unsaponifiable matter (%w/w), d: Saponifiable matter,
e: Free fatty acid, f: Total saturated %, g: Total unsaturated (%).

Table-7 Mineral content (mg/100g) of common oils and bhekal oil

Species	P	Zn	Ca	Mg	K	Na	Fe	Cu
Soya been oil (*Sojamax*)	690.2	3.41	242.6	178.9	0.009	0.011	11.1	1.14
Mustard seed oil (*Brassica compestris*)	694.3	4.86	492.1	0.034	0.019	0.007	8.11	0.84
Ground nut oil (*Arachis hypogoes*)	349	3.91	86.4	0.048	0.007	0.011	2.62	0.92
Cotton seed oil (*Gossium*)	256	1.25	135.6	1.23	----	---	2.89	0.86
Linseed oil (*Linum usitatissum*)	374	3.68	168.9	0.021	0.09	0.026	2.76	1.92
Sunflower Seed oil (*Helianthus annus*)	671.0	5.31	280.0	0.096	0.042	0.011	4.84	1.61
Coconut oil (*Cocos nucifera*)	208	4.96	402.8	0.084	0.86	0.41	7.89	1.33
Almond seed oil (*Prunus arnygdalys*)	484	3.61	239.2	374.6	0.019	0.054	4.26	0.98
Wild apricot seed (*Prunus armenica*)	472	3.79	330.0	370.0	0.017	0.34	3.6	1.56
Bhekal seed oil (*Prinsepia utilis*)	**428**	**3.19**	**312**	**3.21**	**1.02**	**0.48**	**3.90**	**1.32**

Bhekal oil have nearly same ratio of oleic acid and just double of fatty acid as compared to coconut oil and significantly lesser than that of other taken CUOs e.g. mustard oil, cotton seed oil, soybean oil, linseed oil, almond oil, except coconut oil which contains high amount of saturated fatty acids. The results of comparison, in between different CUOs and wild bhekal seed oil, clearly indicate that the values of chemical properties like acid value, iodine value, saponifiable matter, are highly comparable with sunflower oil and almond seed oil (Prunus arnygdalys). Hence with these chemical values, the wild bhekal seed oil may also be suggested as a good alternative for sunflower oil and almond seed oil in industries and food purposes.

Conclusion

The present study envisages that bhekal seed oil from the Chakrata forest division have almost same Physico-chemical properties as in other conventional oils. Bhekal seed have higher yield of oil over 50%, which is comparable to the oil yield of some commercial seed oils such as soyabean oil, mustard seed oil, ground nut oil, cotton seed oil, coconut oil, wild apricot oil But lower than almond seed oil and sunflower oil. Many of the physico-chemical properties of the seed oil studied have close similarity with other commercial seed oils. The results obtained from this study could be used as baseline data to develop bhekal oil (*P. utilis*) for both domestic and industrial purposes and also for promotion and cultivation of this shrub with a sustainable manner in the Garhwal (India) region for large scale production of oil.

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