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Short Communication

Physicochemical Characteristics and Fatty Acid Profile of Yarrow (*Achillea tenuifolia*) Seed Oil

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ABSTRACT

The oil extracted from Yarrow (*Achillea tenuifolia* L.) seed was analyzed for its chemical and physical characteristics such as acid, iodine, peroxide and saponification values as well as specific gravity, refractive index and color. Fatty acids composition of the oil was determined by gas chromatography (GC). Linoleic (69.4%) and oleic (14.5%) acids were the most abundant fatty acids. The oil also contained 1.7% linolenic acid as another polyunsaturated fatty acid. High content of the seed oil rich in linoleic acid (essential fatty acid) is promising to develop this plant and use its seed oil for nutritional and pharmaceutical purposes.

Key Words: Yarrow; Seed oil; Chemical and physical characteristics

INTRODUCTION

Fatty acids are primary nutritional components found in seed oils. Evidence suggests that polyunsaturated fatty acids ($PUFA_s$) especially linoleic acid (LA) and linolenic acid (LN) are essential to human health. However, due to incapability of human body to synthesize these fatty acids, they are provided in the diet (Yu *et al*., 2005). Therefore, more studies were carried out to introduce the new oilseeds with high nutritional and pharmaceutical values (Oomah *et al*., 2000, 02; Besbes *et al*., 2005; Yamasaki *et al*., 2006).

The genus *Achillea* is represented by about 100 species mostly found in Europe, Asia and North America; of these, 19 species of the genus were reported from Iran. Yarrow (*Achillea tenuifolia* Lam.) is one of the native species which grows wildly in different regions of Iran (Rechinger, 1963). This plant has been used as a medicinal herb for a long time and it now is an important drug used both in folk and official medicines (Fiume, 2001; Teixeira Da Silva, 2004).

The most of the work on this species was conducted on its essential oil composition (Aghjani *et al*., 2000; Jaimand & Rezaee, 2001; Dokhani *et al*., 2005). However, no study has been carried out on oil content of yarrow seed and its quality. The objectives of this paper were to determine oil content of yarrow seed and investigate on physicochemical characteristics as well as fatty acids composition of the oil.

MATERIALS AND METHODS

Mature seeds of one population of yarrow were collected from central regions of Iran (Tehran province) and aerial parts of fully flowered of this species were identified as *Achillea tenuifolia* Lam. by V. Mozaffarian (Research Institute of Forests & Rangelands, Tehran) using Flora Iranica (Rechinger, 1963). Herbarium voucher specimen was deposited at herbarium of Isfahan University of Technology, Isfahan, Iran.

Extraction and physico-chemical characteristics of oil. All extractions and analysis were performed in triplicate. The oil was extracted using petroleum ether as solvent in Soxhlet apparatus. The solvent was removed by rotary vacuum evaporator and the oil was stored in refrigerator for following experiments. Acid value of the extracted oil was determined according to AOCS method Cd 3d-63. The percentage of free fatty acids was calculated based on oleic acid. Iodine value of the oil was determined according to AOCS method Cd 1-25. Saponification value of the oil was determined according to AOCS method Cd 3-25. Peroxide value of the oil was determined according to AOCS method Cd 8-53. Specific gravity of the oil was determined by Pycnometer method (AOCS method Cc10a-25) and reported at 20/20°C. The color was read using Lovibond Tintometer instrument in 1-inch cell (AOCS method Cc13e-92), while Refractive index was determined using digital Refractometer (RX-500α, Japan) according to AOCS (2004) method Cc 7-25.

Fatty acids composition. To determine fatty acids profile of the oil, the sample was methylated according to AOAC method (2002). Methylated sample (1 µL) was injected into the gas chromatograph (Chrompac, CP9001) equipped with Flame Ionization Detector (FID) and fatty acid methyl esters were separated using CP Sill-88 fused silica WCOT (50 m×0.25 mm×0.2 µm) and helium gas as carrier at a pressure of 70 kPa. Initial temperature of the column was 160°C for

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Table I. Fatty acids composition of yarrow seed oil compared to commercial vegetable oils and borage seed oil

Fatty acids	Yarrow	Soybean[a]	Canola[a]	Sunflower[a]	Borage seed[b]
Palmitic acid (16:0)	8.55±0.02	11.0	3.9	6.8	13.2
Stearic acid (18:0)	1.52±0.01	4.0	1.9	4.7	5.0
Saturated fatty acids	10.07	15.0	5.8	11.5	18.2
Oleic acid (18:1)	14.51±0.03	23.4	64.1	18.6	20.7
Linoleic acid (18:2)	69.42±0.02	53.2	18.7	68.2	39.0
Linolenic acid (18:3)	1.73±0.03	7.8	9.2	0.5	21.6
Gadoleic acid (20:1)	2.18±0.01	-	1	-	-
Unsaturated fatty acids	87.83	84.4	93	87.3	81.3
Oil content (%)	28.5±0.52	18-20[c]	40-45[c]	35-45[c]	30.1

a: Wang, 2000; b: Gomez *et al*., 2002; c: O'Brien, 1998

Table II. Physicochemical properties of yarrow seed oil compared to crude vegetable oils and borage seed oil

Properties	Yarrow	Soybean[a]	Canola[a]	Sunflower[a]	Borage seed[b]
Acid value (mg KOH g^{-1} oil)	0.77±0.06	0.6	0.6	0.6	NR
%FFA (as oleic acid)	0.38	0.3	0.3	0.3	20.2
Iodine value (g I_2 100 g^{-1} oil)	132.83±0.34	124-139	105-126	118-141	180
Saponification value (mg KOH g^{-1} oil)	158.49±1.38	189-195	182-193	188-194	NR
Peroxide value (meq O_2 kg^{-1} oil)	11.73±0.50	max 10	max 10	max 10	7.8
Color	91R-70Y	NR	NR	NR	NR
Refractive index (25°C)	1.465	1.470-1.476[c]	1.470-1.474[c]	1.472-1.474[c]	1.470
Specific gravity (20/20 °C)	0.85	0.919-0.925	0.914-0.920	0.918-0.923	0.90

a: Codex standard, 1999; b: Gomez *et al*., 2002; c: O'Brien, 1998; NR: Not Reported

32 min and then increased to 220°C at 4°C min^{-1}. The temperature of injector and detector was 250°C. Fatty acids standards for comparison with unknown samples were obtained from Sigma-Aldrich. All chemicals and solvents were of analytical grade, purchased from Merck (Germany).

RESULTS AND DISCUSSION

The oil content of the seed was 28.5%, which is higher than the oil content of commercial oilseeds, soybean and cottonseed (O'Brien, 1998), introducing a new oil source with high oil content. Table I presents a comparison of fatty acids profile of yarrow seed oil and some commercial vegetable oils and borage seed oil (Gomez & Ossa, 2002). Linoleic acid (LA) was the most abundant fatty acid (69.4%), followed by oleic acid (14.5%). The oil also contained linolenic and gadoleic acids as other unsaturated fatty acids. LA content of the oil was higher than other oils, which provides a high nutritional value. Moreover, it contained 1.7% of linolenic acid, which reinforces its oxidative stability compared to soybean, canola and borage oils. Data showed that only yarrow seed and canola oils had higher amounts (2.1%) of gadoleic acid (Table I). Total unsaturation of fatty acids for this oil was more comparable to the value for sunflower and soybean oils. In terms of abundant fatty acids, the oil had close similarity to sunflower oil and could be categorized into the group of linoleic-oleic oils. Saturated fatty acids were palmitic and stearic acids, which included 10.0% of total fatty acids.

Physicochemical characteristics of the oil were compared to crude vegetable oils and borage seed oil (Table II). Although the oil was crude and no refining process was carried out, acid and peroxide values of the yarrow oil were low and nearly similar to these parameters for other oils (except %FFA in borage seed oil). Saponification value of the oil was 158.4, which was much lower than other oils, showing higher molecular weight of fatty acids in yarrow seed oil. Iodine value of the oil was comparable to this index for soybean and sunflower oils, meaning high content of unsaturated fatty acids; however, this value was much higher for borage seed oil (Table II).

For physical properties, specific gravity of the oil was 0.856 which was lower than this value for other oils, while it gave a refractive index of 1.465. The oil had a dark reddish-brown color (similar to color of crude cottonseed oil), which is probably due to colored compounds extracted from the seed, which necessitated a bleaching process before consumption. In terms of physicochemical properties and fatty acids profile, yarrow seed oil is quite similar to sunflower oil.

CONCLUSION

Yarrow seed has high content of the oil which is rich in linoleic acid (essential polyunsaturated fatty acid). This indicated that yarrow seed can be conveniently used to extract oil for human consumption.

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