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Comparison of Some Physical Chemical Properties of Wheat Germ Oils Obtained By Cold Press and Super Carbon Dioxide Extraction Method

Research Article

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Abstract

In this study, moisture, free fatty acids, peroxide, iodine number, the amount of unsaponifiable matter, saponification number, fatty acid composition and sterol analyzes were carried out to determine physicochemical properties of germ oils obtained by cold press and supercritical carbon dioxide extraction method. While the maximum oil yield was found to be 1% as a result of cold pressing process to obtain oil from germ raw material, the maximum oil yield was found to be 9% as a result of the supercritical carbon dioxide process which is another one of the oil extraction methods. The dominant fatty acids in the samples were palmitic, oleic and linoleic acid. And these values were for cold press and SC-CO_2 extraction wheat germ oil respectively; for palmitic acids 16,751% and 17,208%, for oleic acids 17, 065% and17,255%, for linoleic acids 54,789% and 54,339% determined. When sterol analysis of oils extracted by both methods is examined, campasterol and beta sitosterol are seen to be the main sterol varieties found in the oils. In germ oils obtained with cold press and supercritical carbon dioxide extraction methods, respectively, 24,19 and 23,44% campesterol, and 60,98 and 61,56% beta sitosterol were found. This study showed that there was not much difference between fatty acid compositions and sterol composition between extracted oils in both extraction methods, but that there were differences in free fatty acids and peroxide values. Cold press wheat germ oil peroxide value was found 8.90 meqO_2/kg oil whereas SC-CO_2 peroxide value was found 15.80 meqO_2/kg oil.

Keywords: Wheat germ oil; Cold pres; Super critical carbon dioxide extraction; Sterols; Fatty acids

Introduction

Wheat consists of endosperm, bran and germ, and these ratios approximately vary between 81-84%, 14-16% and 2-3% respectively [1]. The maximum yield is obtained from endosperm when wheat is ground for flour production. Germ is a by-product of wheat flour industry.

Wheat varieties contain different amounts of oil depending on the type. Wheat seed has a lipid content of 2-4%. Wheat germ contains 8-14% fat. Wheat germ is a by-product in the flour industry. It has a very high nutritional content. It contains about 52% carbohydrate, 23% protein, 11% water, 10% fat and 4% ash. Thanks to its tocopherol content, it has high nutritional value among vegetable oils [2].

Mechanical extraction (pressing) or organic solvent extraction is one of the most commonly used methods for germ oil. Solvent extraction is the most commonly used method [3].

In germ oil extraction, supercritical carbon dioxide extraction and cold press are some of the oil extraction methods [4].

Germ oil has the highest tocopherol content among all vegetable oils. Its tocopherol content is about 2500 mg/kg and it also has the highest α-tocopherol content which is 60% of its total tocopherol content [2]. Germ oil also has high content of unsaturated fatty acids. These are around 80%. Generally, it has a high proportion of linoleic (18:2) and linolenic (18:3) acid [5]. Both of these are important for the human metabolism and cannot be produced by the body. They are precursors to the production of a group of hormones called prostaglandin and support the development and improvement of muscle structure and inflammation system [6]. In addition, linoleic acid helps to lower cholesterol and is precursor to phospholipids of the cell membrane [7].

In this study, wheat germ oil will be extracted by cold press

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method, applied without high heat treatment to preserve its nutritional properties and with supercritical carbon dioxide extraction in accordance with today's modern technology; and determining characteristics, such as the moisture, free fatty acids, peroxide, iodine number, the amount of unsaponifiable matter, saponification number, fatty acid and sterol values of the extracted oils were evaluated and compared.

Material and Method

Material

Wheat germ was used as raw material in the research. Germ was procured from Altınapa Milling Inc.

Method

Procuring germ oil: Obtaining germ oil with cold press method: Cold press oils: Oils obtained only by mechanical methods without heat treatment.

The oil extraction by cold pressing method with the raw material of the supplied germ was carried out at Helvacizade Food Pharmaceutical Chemicals Inc. The extracted oils were hermetically sealed and are kept away from sunlight and heat.

Obtaining germ oil with supercritical carbon dioxide extraction

Supercritical carbon dioxide extraction was performed under laboratory conditions [8,9]. The lab consists of 400 m^3 extraction tank and 200 and 300 m^3 2 separator tanks. Extraction is a semi-continuous system. It is fed with vegetable material and continuous solvent flow. Germ oil was extracted by using only one separator at 40 °C at 200, 250 and 300 bar pressure [10].

Physical analyses

Determination of moisture content: Moisture content of wheat germ was determined using TS 1607 ISO 662 method with drying oven technique [11].

Chemical analyses

The fatty acids, peroxide number, iodine number, saponification number and the amount of unsaponifiable matter in oils obtained by cold press and SC-CO_2 were determined. These analyzes were conducted with the following methods; TSE 894, TS 4964 ISO 3960, TS EN ISO 3961, TS EN ISO 3657, TS 4963 respectively [12-16]. In addition, fatty acid composition was determined with the TS EN ISO 12966-1 method and determination of sterol was made with the TS EN ISO 12228-1 method [17,18].

Results

The moisture, free fatty acids, peroxide, iodine number, the amount of unsaponifiable matter (%), and saponification number of germ oils obtained by supercritical carbon dioxide extraction and cold press method are given in the Table 1.

When the physicochemical properties of germ oil obtained by cold press method were examined, the values were determined as follows; moisture 0.097%, free fatty acids 0.84%, peroxide 8.9 meqO_2/kg, iodine 132, unsaponifiable matter 6.5 g/kg, saponification number 197 mgKOH/g oil. And in oils obtained by supercritical carbon dioxide extraction method, these properties were; moisture, 13.32%, free fatty acids, 5.9%, peroxide 15.8 meqO_2/kg, iodine 128, unsaponifiable matter 8,04 g/kg, saponification number 182 mgKOH/g oil.

Fatty acid composition

Fatty acid compositions of germ oils obtained using supercritical carbon dioxide extraction and cold press methods are given in Table 2.

In the acid composition of the oils extracted by both methods herein; 8:0, 12:0, 14:0, 16:0, 16:1, 18:0, 18:1, 18:2, 20:0, 20:1, 18:3, 22:0, 22:1 fatty acids were examined. The main fatty acids in the oil extracted by both methods were determined as palmitic, oleic and linoleic (Figure 1).

Table 1: Comparison of some physical chemical properties of wheat germ oils obtained by cold press and SC-CO_2 method.

Analyses	Cold press	SC-CO_2
Moisture (%)	0.097 ± 0.001*	13.32 ± 2.27
Free Fatty Acids (% oleic)	0.84 ± 0.07	5.90 ± 1.30
Peroxide (meqO_2/kg oil)	8.90 ± 0.14	15.80 ± 3.10
Iodine Value (I_2/100 g)	132 ± 11.80	128 ± 10.20
Unsaponifiable matter (g/kg)	6.50 ± 1.40	8.04 ± 1.10
Saponification number (mgKOH/g)	197 ± 12.70	182 ± 9.80

*average ± standard deviation

Table 2: Comparison of fatty acid composition of wheat germ oils obtained by cold press and SC-CO_2 method.

Fatty Acids (%)	Carbon number	Cold Press (%)	SC-CO_2 (%)
Caprilic Acid	8:00	0.008	0.002
Lauric Acid	12:00	0.06	0.008
Myristic Acid	14:00	0.108	0.088
Palmitic Acid	16:00	16.751	17.208
Palmitoleic Acid	16:01	0.148	0.153
Stearic Acid	18:00	0.803	0.794
Oleic Acid	18:01	17.065	17.255
Linoleic Acid	18:02	54.789	54.339
Arachidic Acid	20:00	0.173	0.177
Gondoic Acid	20:01	1.508	1.531
Linolenic Acid	18:03	7.307	7.012
Behenic Acid	22:00	0.094	0.089
Erucic Acid	22:01	0.265	0.258

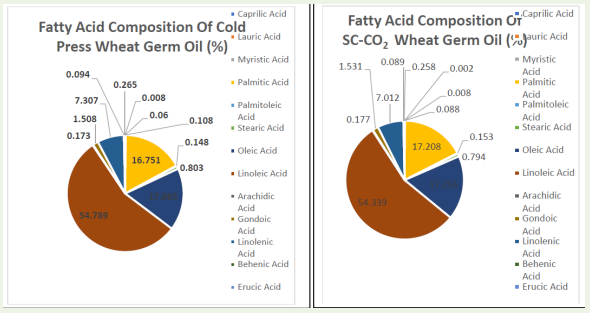

Figure 1: Graphical Demonstration of fatty acid composition of wheat germ oils obtained by cold press and SC-CO2 method.

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Germ oil has mostly linoleic acid 59.4%, followed by 18.8% palmitic acid and 14.3% oleic acid [19]. These values are close to the values present in the literature [5,20].

Sterol value

Sterol values of germ oils obtained with supercritical carbon dioxide extraction and cold press methods are given in Table 3.

When sterol analysis of oils extracted by both methods is examined, campasterol and beta sitosterol are seen to be the main sterol varieties found in the oils. In germ oils obtained with cold press and supercritical carbon dioxide extraction methods, respectively, 24,19 and 23,44% campesterol, and 60,98 and 61,56% beta sitosterol were found (Figure 2).

Discussion

In their study, Jiang and Niu, (2011) determined the physical and chemical properties of germ oil obtained by different methods as follows; in the germ oil extracted by SE method, moisture, 0.68±0.02, acid value, 12.8±0.8 mgKOH/g, peroxide number 2.95±0.04 mmol/kg, saponification number 121.5±1.98 mgKOH/g, iodine number 142.8±1.85, amount of unsaponifiable matter 3.34±0.05% and in the germ oils extracted by SFE method, moisture, 0.47±0.08, acid value, 9.1±0.2 mgKOH/g, peroxide number 2.05±0.09 mmol/kg, saponification number 169.3±1.52 mgKOH/g, iodine number 149.1±1.34, amount of unsaponifiable matter 4.16±0.08%. These results showed that the quality of germ oil obtained by SFE is higher. Particularly, the acid value, peroxide number and color of germ oil are of better quality than germ oil obtained by SE method. This is because in SFE, the bioactive components without the use of any solvent with low pressure (30 MPa), short extraction time (1.7 hours) and low temperature (40 °C).

In this study, physicochemical properties of germ oil obtained by supercritical carbon dioxide extraction and cold press were investigated and results except moisture, free fatty acids and peroxide were found to be close to each other. The reason for the difference between the values were due to conditions of storage, preservation etc. [21].

The average temperature in germ oil obtained by cold press is around 40 °C. When the moisture content, as one of physicochemical properties of the oils obtained with these methods is examined, it was found to be 0.097%, in cold press and 13.32% in supercritical carbon dioxide extraction. The moisture was determined using the special drying oven method. There is a significant difference between these results. This is probably due to storage conditions of the raw material or extraction conditions during oil extraction [21]. It was reported that the moisture content of the product may vary depending on the extraction conditions and the moisture content of the raw material [22-24]. In SC-CO_2s with industrial grade production vegetable oils must be separated before pressure process with high water content.

State that fatty acid compositions of germ oils are similar in both supercritical and hexane extraction methods [25]. State that as a result of their study, there were no major differences between the fatty acid compositions of refined germ oil and germ oil produced with supercritical technology.

The comparative results of the fatty acids composition of germ oil produced by SC-CO_2 and cold press are given in Table 2. They were observed to be parallel with the values stated in the literature, there was not much difference between the results.

Therefore, the fatty acid composition does not differ much depending on the extraction technique.

Phytosterols are major components of the non-saponifying portion of germ oil. According to Itoh et al. (1973) [26], germ oil contains a higher proportion of phytosterol than other commercial oils. Sitosterol (60-70%) and campesterol (20-30%) are the two major sterols found in germ oil [27,28]. Most phytosterols in germ oil are present in ester form [29].

In this study, germ oil was extracted by supercritical carbon dioxide extraction and cold press methods and the comparative results are given in Table 2. When the results are examined, as indicated in the literature, the main vegetable sterol was found to be beta sitosterol (approximately 60% of the total sterols) followed by campasterol (about 25% of total sterols).

Conclusion

This study was carried out to extract oil from the raw germ material using supercritical carbon dioxide extraction and cold press methods. Germ oil is among the functional foods and contains many components that are beneficial to human health. This study demonstrated that germ oil has a high content of unsaturated fat and useful phytosterols, regardless of the method of extraction. However, in terms of physicochemical properties, the amount of moisture, free

Table 3: Sterol contents of wheat germ oils obtained by cold press and SC-CO_2 method (%).

Sterols (%)	Cold Press (%)	SC-CO_2 (%)
Cholestanol	18:02	1.239
Brassicasterol	4:16	0.285
24-Methylene cholesterol	7:53	0.53
Cholesterol	0:00	0
Campesterol	4:37	23.444
Campestanol	0:18	0.068
Stigmasterol	18:36	0.845
Delta7-campesterol	10:26	1.178
Delta-5,23-Stigmastadienol	10:58	1.269
Beta Sitosterol	23:38	61.567
Sitostanol	14:09	1.99

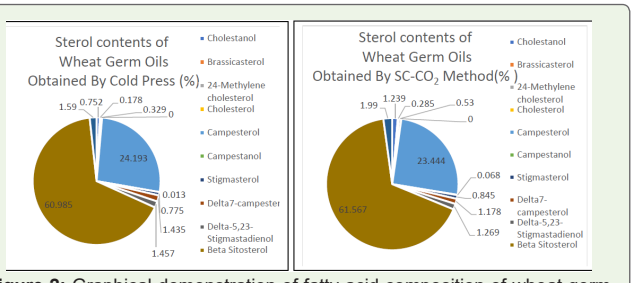

Figure 2: Graphical demonstration of fatty acid composition of wheat germ oils obtained by cold press and SC-CO2 method.

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fatty acids, peroxide and amount of unsaponifiable matter were lower in the germ oil obtained by cold press, and the number of iodine and saponification was lower in the oil obtained by supercritical carbon dioxide extraction.

Along with the importance of the oil extraction method, germ oil contains many nutritionally beneficial components. Cold press has hence drawn the interest of consumers because of nutritional contents and naturality of the oils. Since no heat treatment and chemical process is used during the cold press process, all beneficial nutritional properties of the raw material are transmitted to the oil. Therefore, cold pressed seed oils have high dietary and sensory properties, and contain useful elements with significant chemical properties for health. Cold pressed seed oils contain natural phytochemicals such as tocopherols, fatty acids, sterols and antioxidant phenolic compounds. And wheat germ oil contains, beneficial unsaturated fatty acids, sterols so it is beneficial for human health.

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