The Effect of Climatic Factors on the Production and Quality of Castor Oil

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Abstract: The versatile application of castor oil in different pharmaceutical, chemical, sanitary, cosmetic, biodiesel, and recently in food industry because of its unique physicochemical properties has led castor oil to be the focus of abundant research projects. In this research, the impact of 10 different climatic conditions in Iran on the castor oil production by castor bean (*Ricinus communis* L.) from the standpoints of the quality, oil content and physicochemical properties of castor oil was investigated. With the analyzed oil samples, oil content, moisture content, refractive index, chlorophyll content, saponification value, iodine value, acid value, and peroxide value were respectively determined as 35%-56%, 0.3%-1.2%, 1.404-1.430, 0.02-0.4 mg Phenophytin/ kg Oil, 164-179 mg KOH/g Oil, 75-86 g I_2/100 g Oil, 0.2-0.9 mg NaOH/g Oil, 0-0.5 meq O2/Kg Oil. Castor oils from various regions were significantly (p<0.05) different from the viewpoint of oil content, moisture content, chlorophyll content, acid value, peroxide value, saponification value, and iodine value, but indicated no considerable difference (p>0.05) in their refractive indices. The plants grown under climatic conditions of Nur Abad region were of the highest level of oil content (56%) indicating the most favorable meteorological and soil physicochemical conditions in the area. From the standpoint of oil stability and quality, the oil from Marand, Urmia and Nazarlu were of proper conditions. The present research is the first report on the quality, oil content, and physicochemical properties of castor oil extracted from castor beans harvested in different regions in Iran.

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1. Introduction

Castor bean (*Ricinus communis*) is a species that belonging to the Euphorbiaceae family. In tropical climates the castor bean is a perennial plant grows to heights of 10 to 12 meters and in temperate climates it is an annual, with height of one to three meters are more common (Weibel, 1948). Castor seeds contain a variable percentage of 40-60% oil averaging 50%, which is quite high when compared to any other oil seeds available (Brigham, 1967). Worldwide castor production was about 1.4 million metric tons during the year 2009 with an average yield of about 956 kg ha^{-1} (FAO, 2009).

Ricinoleic acid (12-hydroxy-9-octadecenoic acid), is the major component of castor oil, and contained about 89% of the total fatty acid complement, allowing castor oil to be miscible with methanol and ethanol, giving it an advantage in trans-esterification to biodiesel. Presence of hydroxyl groups and double bonds makes the oil suitable for many chemical reactions and modifications (Ogunniyi, 2006). Castor beans are traditionally processed into oil by single or double-pressing, or by pressing followed by batch solvent-extraction (D'Aquin *et al.*, 1960). Because the amount of castor seeds oil is high, so the most common method for extraction of oil is cold press extraction and extraction solvent is next. Considering that quality of cold press oil extraction is high and better protect its natural properties and is free of chemicals (Anderson, 1996), Therefore is used its castor oil as the most valuable materials, anti-flushing, purgative and laxative in medicine. On the other hand oil from solvent extraction used in pharmaceutical, cosmetics and health industries and biodiesel fuels in the more developed countries. Medicinal effects Castor bean is because Phytochemical compounds such as flavonoids, alkaloids and tannin (Ilavarasan *et al.*, 2006).

Physicochemical properties of oil can be directly affected by a combination of fatty acids, triacyl Glycerol and oil content that can, different depending on seed varieties and some other factors such as weather conditions and soil type (Ogunniyi, 2006). Generally climate composed from collection of edaphic and climate factors that should noted them impact on growth, development, yield and rate of medicinal plants active substance. The most important environmental factors that affect on medicinal plant quantity and quality of active substance are including light, temperature, rainfall, latitude, soil characteristics, Altitude and nutrition (Omidbaigi, 2009).

Because of the importance of medicinal castor bean plant and its oil in pharmaceutical, cosmetics and hygienic industries, nowadays in food science and needs of our country future to this crop should be done many studies on this Valuable plant. For this purpose, a study was carry out on castor oil Physicochemical properties to find best location weather conditions of Iran.

2. Materials and methods

2.1. Samples

For this research Seeds of medicinal castor bean plants were planted in 10 regions of different climates in spring 2008. All 10 sites (North and West of Tehran province, Shabestar, Nazarlu, Sarbangholi, Marand and Urmia in Azarbayjan and Nur Abad, Masiri and Mangudarz in Fars province) had different weather and soil types. In the laboratory after separate of impurities, grain was dried until moisture 8% and finally they were ground for oil extraction. This research was carry out in completely randomized design with 3 replications for each test.

2.2. Oil extraction

After removal of the seed coat, the seeds (50g) of Castor bean were crushed and extracted in a Soxhlet apparatus fitted with a 1-L round-bottomed flask and a condenser. The extraction was carried out on a water bath for 6 h with 0.40 L of n-hexane. The solvent was removed under vacuum in a rotary evaporator (EYELA, N.N. Series, Rikakikai Co. Ltd., Tokyo, Japan) (Azadmard-Damirchi *et al.*, 2005).

2.3. Chemical analysis

2.3.1. Determination of acid value

For Determine the acid value of oil was used according to AOCS procedure and cd 3d-40 number and the results were reported based on Oleic acid percentage.

2.3.2. Determination of peroxide value

For Determine the peroxide value of oil was used according to AOCS procedure and cd 8-53 number and the results were reported based on meq O_2/Kg Oil.

2.3.3. Determination of saponification value

For Determine the Saponification value of oil was used according to AOCS procedure and cd-3-35 number and the results were reported based on mg KOH/g Oil.

2.3.4. Determination of iodine value

Iodine value was calculated according to Hanos method and results were reported on based g I_2/100 g Oil (Weaver and Daniel, 2003).

2.4. Physical properties

2.4.1. Determination of castor oil rate

After oil extraction, oil rate was calculated for each region (Uquiche *et al.*, 2008).

2.4.2. Determination of moisture content of the oil

Amount of moisture of oil content was calculated according to AOCS procedure and 925.09 numbers.

2.4.3. Determination of chlorophyll content

Chlorophyll content of castor oil samples were measured using the Spectrophotometers method (Pokoprny *et al*., 1995).

2.4.4. Determination of refractive index

For Determine the refractive index of castor oil was used from refractometer set in temperature 25°C (Hoseini, 1994).

2.5. Statistical analysis

The data were objected to analysis of variance (ANOVA) using SAS program and differences among treatments were tested with Duncan test (Level of significance p<0.05).

3. Results and discussion

3.1. Chemical properties

Table 1 shows the chemical properties of the castor bean oil that obtained from samples collected from the Iran various regions. Results of this study showed a significant effect of climate on acid value, peroxide value, iodine value (p<0.01) as well as saponification value (p<0.05).

Acid value range was 0.29-0.88 (table 1) which was lower than values determined in other studies due to high concentration of hydroxyl groups in castor oil which can react with free fatty acid during the storage and reduce the acid value through hydrogen binds.

Peroxide value range was 0.00-0.50 (Table 1). Peroxide value is an index for the concentration of oxidation substrate. Peroxide value and acid value are qualitative parameters for oils quality.

Saponification value in samples varied between 164.50-178.53 (table 1) which was lower than values determined in other studies (Ogunniyi, 2006). It can be due to several reasons like climate, physicochemical properties of soil and the changes in oil bonds during storage, which increase the long chain fatty acid in oil (Liauw *et al*., 2008).

Iodine value range was 75.75-85.62 (table 1) which was lower than values determined in other studies (Ogunniyi, 2006; Akpan *et al*., 2006). Oil extracted from seeds harvested in Shabestar, had the lowest iodine value and therefore the highest oxidative stability. Since Iodine value of castor oil is lower than other oils, it is used for coating and lubricating.

3.2. Physical properties

Results from analysis of variance showed that climate had significant effects on oil content and oil moisture (p<0.01) and chlorophyll content (p<0.05) in oil extracted from seeds of castor, however refractive index was not significantly affected by climate. Physical properties of castor bean oil are shown in Table 2.

The comparison of means show that in Nur Abad and Mangodarz, seeds had the highest oil content and in Shabestar and Urmia they had the lowest. Studies showed that oil function like seed function is depended to the plant variety, climate and the interaction between these two factors. They reported the oil function range between 47-53% in different regions (Koutroubas *et al.,* 1999). Others reported castor oil content range between 40-60% (Weiss, 2000).

The oil moisture range in this study was 0.3-1.14%. Among different regions, Urmia has the least value and the highest value was determined in the north of Tehran. This parameter is important to determine the purity and shelf life of the oil. These results are compatible with existing data.

Refractive index in different regions varied between 1.404-1.426 which was concurrent to other studies. Slight differences between studies may be due to differences in study condition, planting and harvesting conditions and conservation of the oil (Akpan *et al.,* 2006).

Chlorophyll content range in this study was 0.02- 0.40. Seeds that were harvested from the north of Tehran had the least chlorophyll in their oil and the highest chlorophyll was in the plants harvested from Masiri region. The chlorophyll value shows the region geographical longitude, seed maturation condition and extraction procedure condition.

4. Consolation

According to the physicochemical properties of castor oil extracted from seeds harvested in different regions, we can conclude that Urmia, Nazarlu and Marand have the highest quality oils

Table 1. Chemical properties of the castor bean oil

Region	A.V[1]	P.V[2]	S.V[3]	I.V[4]
North of Tehran	0.41d	0.50a	164.50c	83.67ab
West of Tehran	0.50c	0.01c	174.12ab	85.62a
Shabestar	0.29f	0.00c	171.03abc	75.75c
Nazarlu	0.60b	0.00c	178.53a	85.14a
Sarbangholi	0.30f	0.00c	168.22bc	83.72ab
Marand	0.59b	0.00c	167.62bc	81.85ab
Urmia	0.41ed	0.00c	177.62a	85.09a
Nur Abad	0.88a	0.00c	167.66bc	78.79bc
Masiri	0.29f	0.45b	168.37bc	80.60ab
Mangudarz	0.39e	0.00c	172.06abc	81.07ab
SEM	0.005	0.012	2.54	1.51

* Means having different superscripts within the column are significantly different at p<0.05. 1. Acid Value (mg NaOH/g Oil) 2. Peroxide Value (meq O_2/Kg Oil) 3. Saponification Value (mg KOH/g Oil) 4. Iodine Value (g I_2/100 g Oil)

Table 2. Physical properties of the castor bean oil

Region	O.C[1]	M.C[2]	R.I[3]	C.C[4]
North of Tehran	42.0d	1.14a	1.415a	0.40a
West of Tehran	51.6b	0.47f	1.426a	0.19abcd
Shabestar	35.3e	0.49e	1.404a	0.39a
Nazarlu	45.3c	0.38g	1.424a	0.18abcd
Sarbangholi	43.3d	0.40g	1.417a	0.30abc
Marand	51.0b	0.69c	1.412a	0.17abcd
Urmia	36.3e	0.35h	1.423a	0.16bcd
Nur Abad	56.2a	0.46f	1.405a	0.12cd
Masiri	43.1d	0.60d	1.409a	0.02d
Mangudarz	52.8b	1.00b	1.412a	0.36ab
SEM	0.55	0.008	0.008	0.068

* Means having different superscripts within the column are significantly different at $p<0.05$. 1. Oil Content (%) 2. Moisture Content (%) 3. efractive Index (25) 4. Chlorophyll Content (mg pheophytin/kg oil)

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5. Refrences

[1] Akpan UG, Jimoh A, Mohammed AD. Extraction, Characterization and Modification of Castor Seed Oil. Leonardo Journal of Sciences. 2006; 8:43-52.

[2] Anderson D. A primer on oils processing technology. J. John Wiley and Sons, Inc. 1996; 4:10-17.

[3] AOCS. Official Methods and recommended practices of the American Oil Chemists' Society, 4th edition. Champaign. IL: AOCS Press. 1993

[4] Azadmard-Damirchi S, Savage GP, Dutta PC. Sterol fractions in hazelnut and virgin olive oils and 4, 4´-dimethylsterols as possible markers for detection of adulteration of virgin olive oil. Journal of the American Oil Chemists' Society. 2005; 82:717-725.

[5] Brigham RD. Natural outcrossing in dwarf-internode castor, Ricinus communis L. Crop Science. 1967; 7:353-354.

[6] D'aquin EL, Pominsky J, Vix HLE, Knoepfler NB, Kulkarni BS, Gastrock EA. Direct Solvent-Extraction of Castor Beans Yields High Grade Oil. Journal of the American Oil Chemists' Society. 1957; 37(2): 93-97.

[7] Food and Agricultural Organization. 2009. www.fao.org

[8] Hoseini Z. Common methods in foods analyses. Shiraz Univ publ. Shiraz 1994

[9] Ilavarasan R, Mallika M, Venkataraman S. Antiinflammatory and free radical scavenging activity of *Ricinus communis* root extract. Journal of Ethnopharmacology. 2006;103:478-80.

[10] Koutroubas SD, Papakosta DK, Doitsinis A. Adaptation and yielding ability of castor plant (*Ricinus communis* L.) genotypes in a Mediterranean climate. European Journal of Agronomy. 1999; 11:227-237.

[11] Liauw MY, Natan FA, Widiyanti P, Ikasari D, Indraswati N, Soetaredjo FE. Extraction of Neem Oil (*Azadirachta indica* A. Juss) Using N-Hexan and Ethanol: Studies of Quality, Kinetic and Thermodynamic. Journal of Engineering and Applied Sciences. 2008; 3(3):49-54.

[12] Ogunniyi DS. Castor oil: A vital industrial raw material. Journal of Biotechnology. 2006; 97:1086-1091.

[13] Omidbaigi R. Production and processing of medicinal plant (3nd edition. Vol. 1). Razavi Ghods Astan Publ, Mashhad. 2009

[14] Pokoprny J, Kalinova L, Dysseler P. Determination of chlorophyll pigments in crude vegetable oils. International Union of Pure and Applied Chemistry. 1995; 67(10):1781-1787.

[15] Uquiche E, Jeréz M, Ortíz J. Effect of pretreatment with microwaves on mechanical extraction yield and quality of vegetable oil from Chilean hazelnuts. Innovative food science emerging technologies. 2008; 9:495-500.

[16] Weaver CM, Daniel JR. The Food Chemistry Laboratory.In: Weibel, RO, ed. The castor-oil plant in the United States. Economic Botany. CRC Press, Boca Raton 2003; 2(3):273-283.

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