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Effect of Hydrothermal Pretreatment of Canola Seeds on Dehulling Efficiency and Oil Quality

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Abstarct: In the present research work, three hydrothermal conditioning methods followed by three different drying treatments were used prior to dehulling of canola seeds. After dehulling, different parameters including dehulling efficiency and quality and quantity of oil extracted from dehhulled seeds were evaluated. The results indicated that the highest dehulling efficiency (86.5%) was obtained by soaking of seeds in distilled water for 100 min followed by hot air drying at 65°C. The seeds dehulled after soaking in distilled water for 70 and 100 min followed by hot air drying either in 55 or 65°C showed higher oil content compare to dehulled seeds pretreated by other methods. The crude fiber content of dehulled seeds was decreased as a result of increasing the dehulling efficiency. The highest acidity value (0.81%) was obtained from soaking pre-treatments for 100 min followed by sun drying. There was significant differences ($P<0.05$) between acidity values of oil extracted from dehulled seeds dried by sun and hot air. However, the results showed no significant difference between the acidity value of oil extracted from dehulled seeds dried by two different temperatures. The pre-treated sun dried seeds showed higher peroxide values compared to those dried by hot air method. However, the differences were not statistically significant ($P<0.05$) in most replicates.

Key words: Canola · Dehulling · Conditioning · Oil quantity · Oil quality

INTRODUCTION

Rapeseed/canola contains about 40-45% oil and 20-25% protein and is one of the most important oilseed crops in the world. The rapeseed/canola meal contains high amount of protein (38-43%). The protein is of excellent nutritional quality being rich in lysine with adequate amount of sulphur containing amino acids-limiting amino acids in most of cereals and oilseed proteins [1]. The presence of toxic and anti-nutritional constituents such as glucosinolates, phytates and phenolics limits the use of rapeseed meal as a source of protein in food products [2]. Dehulling of rapeseed before oil extraction is a treatment that can improves meal and oil quality and makes the resultant product suitable for human consumption [3-5]. For effective and efficient utilization of rapeseed/canola meal in human diet a number of appropriate processing technologies are adopted. The content of hulls in rapeseed/canola varies from 10.5 to 20% of seed weight and 20-30% in defatted meal [6,7]. The commercial rapeseed meal contains 12.1% crude fiber, most of which is derived from hulls. The use of hulls in feed formulation decreases the feeding value and digestibility. This may be due to the blocking effect of hull anti-nutritional constituents on the alimentary protein or enzymes of gastro-intestinal tract [8, 9]. Thus dehulling may serve as an important process in improving the nutritional value of rapeseed and canola meals for animal feed and human food formulations.

A number of processes for dehulling of rapeseed/canola have been proposed and reported. The removal of hulls can be accomplished by air-classification of defatted meal [10, 11], liquid cyclone fractionation after solvent extraction [12], cracking and air classification [13-15] or by hydrothermal pretreatment for loosening of hull and abrasive dehulling of seed [16]. At present the hulls of rapeseed/canola are not commonly removed in the commercial plants. The small seed size and the oil loss in the hull are among the reasons why whole grain crushing is preferred. Moreover, the close association between the cotyledon and the hull makes dehulling a difficult operation [17]. The dehulling efficiency depends on the

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severity of adhesion of hull to endosperm. The objective of the present study was to investigate the effects of different hydrothermal pre-treatment methods on the dehulling efficiency and the quantity and quality of the oil extracted from the dehulled seeds of canola.

MATERIALS AND METHODS

Materials: Canola seeds (variety PF 7045, 91) was purchased from National Oilseed Development Corporation Ltd., Gorgan, Iran. The moisture content of seed was around 14%. The seeds were hand-cleaned and stored in an air-tight container at room temperature until use. All chemicals used were of analytical grade and purchased from Sigma chemicals (Sigma, Mumbai, India).

Methods

Conditioning of Seeds: Canola seeds (5 kg) were pre-treated by the following methods: (a) soaking of seeds for 70 and 100 min (b) steaming the seeds with saturated steam in an opened lid autoclave (Mega Medical Tools, 35 liter, Iran) for 5 and 10 min and (c) exposing the seeds at pressure 1 Barr for 5 and 10 min in the autoclave. Seeds were then dried with three different treatments including sun drying and hot air drying using a cabinet drier (TABAI ESPEC Corp., Japan) at two different drying temperatures of 55 and 65°C. Canola seeds without pre-treatment were used as control.

Dehulling of Seeds: Dehulling of seeds was carried out in a rice dehusker (Partsazan Co., Ltd, Iran). This machine contains two rolls that rotate in different speed (1.5:1). The clearance between the rolls was set for canola seeds before conducting the experiments. Samples weighing 1000 g each were fed through the hopper and allowed to pass between the rolls. This caused the seeds to split between the rolls. The dehulled products were separated into unhulled seeds, dehulled seeds, brokens, powder and hulls by sieving. The hulling efficiency was calculated using the formula suggested by Saxena [18] for pigeon pea, given as below:

$$\text{Hulling Efficiency, \%} = (1-\frac{Wuh}{Wt})(\frac{Wd}{Wd+Wbr+Wp})\times 100$$

Where:

W_{uh} = Unhulled seed weight g;
W_t = Total sample weight, g
W_d = Weight of dehulled seed, g;
W_{br} = Weight of brokens, g
W_p = Weight of powder, g

Chemical Analysis: The different samples were analyzed according to AOAC standard methods number 962.09, 972.28, 940.28, 965.33 for crude fiber, oil, free fatty acid and peroxide value of the oil, respectively [19].

RESULTS AND DISCUSSION

The effect of different pre-treatments on dehulling efficiency of seeds compared to control sample are presented in Table 1. The highest dehulling efficiency (86.5%) resulted from soaking the seeds for 100 min followed by hot air drying at 65°C, while the lowest dehulling efficiency (67%) resulted from steaming the seeds with saturated steam for 5 min followed by sun drying. There was no significant difference between dehulling efficiency of seeds using two soaking pre-treatments followed by hot air drying at either 55°C or 65°C. It seems hydrothermal pretreatments loosen the seeds hull and improve dehulling efficiency. Thakor *et al*. [16] reported that raising the moisture content of the whole seeds from 6 to 15% by exposing them to steam, followed by drying in a fluidized bed drier resulted in the maximum dehulling efficiency.

Table 2 summarises the result of the effect of different conditioning treatments on the oil content of dehulled seeds. The oil content of dehulled seeds using soaking pre-treatments for 70 and 100 min followed by drying at 65°C was 43.4 and 43.7%, respectively. The higher oil content of dehulled seeds using soaking pre-treatments followed by hot air drying at 65°C is in line with higher dehulling efficiency of these treatments compared to other methods.

The lowest oil content of the dehulled seeds resulted from seeds pre-treated with saturated steam for 5 min followed by sun drying (38%). The results clearly showed that there was a correlation between dehulling efficiency and the oil content of dehulled seeds; the lower the dehulling efficiency the lower the oil content.

The effect of different hydrothermal pre-treatments on the crude fiber of dehulled seeds is presented in Table 3. The lowest crude fiber content of 3.2% was obtained using soaking pre-treatment for 100 min followed by hot air drying at 65°C. This result is in correlation with higher dehulling efficiency of the treatment. It has been reported that commercial rapeseed meal contains 12.1% crude fiber, most of which is derived from hulls. About 50% of commercial meal and 80% of the hull are composed of crude fiber and N-free fractions [8]. Kracht *et al*. [20] reported that dehulling of the rapeseed decreased the crude fiber content in the meal and cake by approximately

Table 1: Effect of different dehulling pre-treatments on dehulling efficiency of seeds

	Drying Method		
Pre-Treatment	Sun Drying	Hot Air Drying 55°C	Hot Air Drying 65°C
Soaking 70 min	77.0±0.7^{fg}	82.0±0.9^{bc}	85.4±0.7^{a}
Soaking 100min	79.0±0.5^{de}	83.0±0.7^{b}	86.5±0.8^{a}
Saturated Steam 5 min	67.0±0.5^{k}	71.0±0.4^{j}	74.0±0.7^{h}
Saturated Steam 10 min	71.5±0.6^{ij}	75.8±0.7^{g}	77.5±0.5^{f}
Autoclaved 5 min	73.0±0.9^{hi}	77.4±0.8^{f}	78.0±0.6^{ef}
Autoclaved 10 min	79.3±0.4^{de}	80.0±0.6^{d}	82.5±0.5^{cd}
Control	49.0±0.8^{m}	55.0±0.7^{l}	57.0 ±.0.8^{l}

Mean ± SD of three determinations *Values followed by similar letter (s) are not significantly different (P<0.05)

Table 2: Effect of different dehulling pre-treatments on oil content of dehulled seeds

	Drying Method		
Pre-Treatment	Sun Drying	Hot Air Drying 55°C	Hot Air Drying 65°C
Soaking 70 min	40.2±0.3^{defg}	42.8±0.2^{ab}	43.4±0.3^{a}
Soaking 100min	41.0±0.2^{cdef}	43.0±0.1^{ab}	43.7±0.2^{a}
Saturated Steam 5 min	39.0±0.3^{gh}	41.3±0.2^{cd}	41.4±0.2^{bcd}
Saturated Steam 10 min	39.2±0.4^{gh}	39.7±0.3^{efg}	41.1±0.3^{cde}
Autoclaved 5 min	39.6±0.3^{fg}	41.4±0.3^{bcd}	41.7±0.3^{bc}
Autoclaved 10 min	39.7±0.3^{efg}	41.2± 0.2^{cde}	42.2±0.4^{abc}
Control	37.5±0.4^{i}	38.0±0.3^{hi}	38.1±0.2^{hi}

Mean ± SD of three determinations *Values followed by similar letter (s) are not significantly different (P<0.05)

Table 3: Effect of different dehulling pre-treatments on crude fiber content of dehulled seeds (%)

	Drying Method		
Pre-Treatment	Sun Drying	Hot Air Drying 55°C	Hot Air Drying 65°C
Soaking 70 min	4.3±0.10^{def*}	3.7±0.09^{hij}	3.4±0.10^{jk}
Soaking 100min	4.1±0.15^{efgh}	3.5±0.12^{ijk}	3.2±0.12^{k}
Saturated Steam 5 min	4.8±0.12^{c}	4.4±0.15^{de}	3.9±0.13^{fghi}
Saturated Steam 10 min	4.7±0.10^{cd}	4.3±0.13^{def}	4.0±0.12^{efgh}
Autoclaved 5 min	4.7±0.08^{cd}	4.1±0.11^{efgh}	3.8±0.14^{ghij}
Autoclaved 10 min	4.2±0.12^{efg}	3.7±0.12^{hij}	3.5±0.10^{ijk}
Control	6.7±0.11^{a}	6.3±0.14^{a}	5.7±0.13^{b}

Mean ± SD of three determinations *Values followed by similar letter (s) are not significantly different (P<0.05)

Table 4: Effect of different dehulling pre-treatments on acidity (based on oleic acid %) of oil extracted from dehulled seeds

	Drying Method		
Pre-Treatment	Sun Drying	Hot Air Drying 55°C	Hot Air Drying 65°C
Soaking 70 min	0.79±0.03^{ab}	0.65±0.01^{gh}	0.63±0.03^{hi}
Soaking 100min	0.81±0.02^{a}	0.68±0.02^{fg}	0.65±0.02^{gh}
Saturated Steam 5 min	0.75±0.02^{cd}	0.62±0.03^{hi}	0.60±0.02^{ij}
Saturated Steam 10 min	0.78±0.03^{abc}	0.64±0.05^{h}	0.62±0.03^{hi}
Autoclaved 5 min	0.76±0.04^{bcd}	0.71±0.03^{ef}	0.69±0.02^{f}
Autoclaved 10 min	0.80±0.03^{a}	0.73±0.02^{de}	0.71±0.04^{ef}
Control	0.63±0.04^{hi}	0.57±0.04^{jk}	0.54±0.03^{k}

Mean ± SD of three determinations *Values followed by similar letter (s) are not significantly different (P<0.05)

Table 5: Effect of different dehulling pre-treatments on peroxide value of oil extracted from dehulled seeds(meqo_2/kg)

	Drying Method		
Pre-Treatment	Sun Drying	Hot Air Drying 55°C	Hot Air Drying 65°C
Soaking 70 min	0.23±0.02[a]	0.19±0.02[ab]	0.10±0.03[b]
Soaking 100min	0.26±0.03[a]	0.21±0.04[a]	0.18±0.02[ab]
Saturated Steam 5 min	0.20±0.02[ab]	0.13±0.02[b]	0.10±0.03[b]
Saturated Steam 10 min	0.21±0.01[a]	0.14±0.03[b]	0.13±0.03[b]
Autoclaved 5 min	0.26±0.03[a]	0.19±0.02[ab]	0.17±0.03[b]
Autoclaved 10 min	0.27±0.02[a]	0.21±0.02[a]	0.19±0.02[ab]
Control	0.20±0.02[ab]	0.18±0.03[ab]	0.15±0.02[b]

Mean ± SD of three determinations *Values followed by similar letter (s) are not significantly different (P<0.05)

40%. Sosulski and Zadernowski [12] studied on fractionation of rapeseed meal into flour and hull components and influence of hull percentage on meal composition. Their result indicated that there was a progressive reduction in crude fiber with decrease in hull percentage among the three *Brassica* species. Therefore, it can be concluded that the higher crude fiber content of 4.8% for the treatment using saturated steam for 5 min followed by sun drying could be due to lower dehulling efficiency of the treatment.

The effect of different conditioning treatments on extracted oil acidity is presented in Table 4. The maximum acidity of 0.79 and 0.81% was obtained from soaking pre-treatments for 70 and 100 min followed by sun drying, respectively. Minimum acidity of 0.60% was obtained from saturated steam pre-treatment for 5 min followed by 65°C hot air drying. In all pretreatment methods, there was significant difference (P<0.05) between the acidity of oil extracted from dehulled seeds dried by sun and hot air, but there was no significant difference between acidity of oil extracted from dehulled seeds dried by hot air either at 55°C or 65°C. Holser [21] studied the effect of moisture and temperature on the oil quality of conditioned meadowfoam *(Limnanthes alba*). He reported that increasing the moisture content and temperature of seeds prior to expelling, increased the levels of free fatty acids (FFA) in the press oils. The increased moisture content of the seeds would promote hydrolysis of triglycerides and it seems moisture to have a stronger effect than temperature. Similarly, we can observe that the higher acidity of oil extracted from seeds pre-treated using soaking for 70 min followed by sun drying could be due the longer exposure of the seeds to moisture which promoted the hydrolysis of triglycerides.

The results of the peroxide value of oil extracted from seeds dehulled using different pretreatment and drying methods are presented in Table 5. The highest peroxide value (0.27 meqo_2/ kg) resulted from seeds autoclaved for 10 min followed by sun drying. In all treatments, the peroxide value of oil extracted from dehulled seeds dried by sun showed higher value compared to seeds dried by hot air either at 55 or 65°C. However the differences were not statistically significant in most of the cases. The higher peroxide value of sun dried seeds could be due to the effect of light on oil peroxidation.

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