

CHEMICAL AND FUNCTIONAL PROPERTIES OF DEFATTED
MEAL OF SOME RAPESEED VARIETIES

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ABSTRACT

Defatted meals of three rapeseed varieties "Orbal", "Cresor" and "Brutor", were prepared to evaluate their chemical and functional properties. Rape meal of variety "Brutor" was characterized by significantly highest crude protein, total carbohydrates, reducing sugars and crude fibers content. Whereas, meal of variety "Orbal" was the lowest in crude protein, total carbohydrates, reducing sugars, trisaccharides, RNA and DNA.

Protein dispersibility index (PDI) was at the minimum when the pH was near the isoelectric point and markedly increased below and above this region. Foam capacity (FC) was in opposite relationship with PDI and emulsion capacity (EC) as a function of pH.

Rape meal of variety "Brutor" characterized by high significant PDI, FC and oil absorption as compared to the other two varieties. Meanwhile, meal of variety "Orbal" had highest EC, emulsion stability, (ES), foam stability (FS), and water absorption. Maximum EC was at pH 9.0 for all studied rape meals, while highest ES was at pH 7.5 for "Orbal" and "Cresor", and at pH 9.0 for "Brutor". Whereas, highest FC for the three rape meals was obtained at pH 6.0 and maximum FS was at pH 7.5.

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INTRODUCTION

Recently, attention has been directed towards the utilization of protein sources including rapeseed. The ultimate success of utilizing plant proteins as proteinacious ingredients depends largely upon the beneficial qualities they impart to foods. Specific functional properties attributed to the protein components of rapeseed include emulsification, whippability and solubility at different pH values as well as fat and water absorption.

Extensive researches had been done on the nutritional and functional properties of rape protein products (Thompson *et al* ., 1982; Thompson and Cho, 1984). They found wide differences in chemical and functional properties as affected by variety and technological processes.

The objective of the present investigation was to assess the chemical and functional properties of defatted meal of three rapeseed varieties namely "Orbal", "Cresor" and "Brutor".

MATERIAL AND METHODS

Materials :

Three rapeseed varieties characterized with no erucic acid content (El-Habbal and Magda, 1987) namely "Orbal", "Cresor" and "Brutor" (1986 crop) were obtained from Crop Science Dept., Faculty of Agric., Ain Shams Univ., Shouba El-Kheima, Cairo.

The seeds were heated at 110°C for 1.5 hours, milled and the oil was extracted using Soxhlet apparatus and hexane as a solvent. The obtained meals were desolventized at 60°C under vacuum.

Properties of defatted meal of rapeseed.

Methods :

Chemical analysis :

Proximate analysis of rape meal including crude protein (N% x 6.25), total carbohydrates, reducing and non reducing sugars, trisaccharides, ash, starch, and crude fibers were carried out using standard procedures (AOAC, 1975) and calculated as percentage on dry weight. DNA and RNA (mg/gm dry sample) were estimated according to Parijs (1967).

Functional properties :

- 1- Protein dispersibility index (PDI): was determined at different pH values according to Thompson *et al.* (1982). Total nitrogen in the supernatants was determined by Microkjeldahl method. PDI was calculated using the following formula:

$$PDI = \frac{\% \text{ water dispersible protein} \times 100}{\% \text{ crude protein}}$$

- 2- Emulsification: Emulsion capacity (EC) and emulsion stability (ES) were justified at different pH values by the method of Beuchat (1977). EC was expressed as gm corn oil emulsified/gm dry sample, and ES as volume of water separated after several times at room temperature.
- 3- Foaming: Foam capacity (FC) was estimated according to Coffman and Garcia (1977) by whipping one gram of the sample in 100 ml distilled water for five minutes at different pH values. FC was calculated as percentage increase in volume.

Foam volume was measured at room temperature after whipping for certain times (min) as an indication of its stability.

- 4- Oil and water absorption: were estimated according to Beuchat (1977). The results were calculated as gm corn germ oil or water absorbed by 100 gm dry sample.

- 5- Statistical analysis: All chemical composition and functional properties were carried out in three replications. The obtained data were exposed to proper statistical analysis of variance as described by Snedecor and Cochran (1969). L.S.D. test was used for comparison between means.

RESULTS AND DISCUSSION

Chemical composition :

The obtained results in Table(1) indicate that rape meal of variety "Brutor" was significantly higher in crude protein, total carbohydrates, reducing sugars, trisaccharides and crude fibers content than that of variety "Orbal". Opposite results were noticed for non reducing sugars and ash contents.

Additionally, it could be seen that there were no significant differences between the meal of both "Cresor" and "Brutor" varieties in chemical composition except in crude protein and crude fibers contents which were significantly lower in "Cresor" variety.

Concerning the RNA and DNA concentrations in studied meals, the results indicated that "Orbal" meal was the lowest in RNA, however, "Cresor" was the highest. These results are true and significant at 5% level of significance.

Functional properties :

1- Protein dispersibility index (PDI):

Regarding PDI, the results in Fig. (1) revealed that minimum PDI was at pH 4.0, near the isoelectric point and markedly increased below and above this region reaching its maximum at pH 10.0.

It could be seen from Table (2) that PDI varied and was significantly affected by genotype of rape variety. Meal protein of variety "Brutor" characterized by high

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Table (1): Proximate analysis of defatted meal of some rapeseed varieties (on dry weight bases).

Components	Defatted meal of rapessed varieties			L.S.D.at 5%
	Orbal	Cresor	Brutor	
Crude protein %	40.08	42.01	43.20	1.13
Total carbohydrates %	17.74	19.89	20.45	1.17
Reducing sugars %	0.96	1.57	1.92	0.43
Non reducing sugars %	8.84	7.22	7.73	0.68
Tri saccharides %	7.83	10.32	10.06	1.12
Starch %	0.82	0.78	0.74	0.03
Ash %	7.92	6.41	6.70	0.65
Crude fibers %	12.39	13.44	14.20	0.74
RNA (mg/gm)	0.55	0.72	0.61	0.07
DNA (mg/gm)	0.21	0.28	0.26	0.03

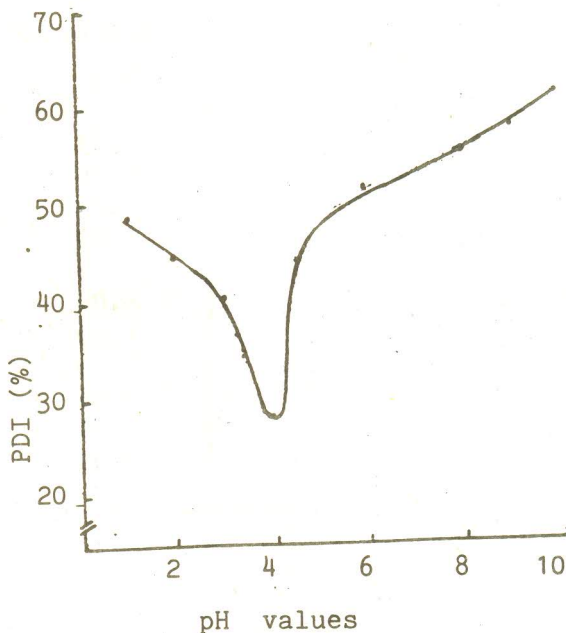


Fig. (1): Average protein despersibility index (PDI) of rape meal varieties as a function of pH.

significant PDI at all studied pH values except pH 4.5. Whereas, "Cresor" had the lowest protein solubility especially at pH 4.0 near the isoelectric point.

The variation in PDI of different studied rape meal varieties as a function of pH might be due to the nature and physicochemical properties of rape protein (Altschul and Wilcke, 1985).

2- Emulsion capacity (EC) and stability (ES):

Fig. (2) shows the mean EC (gm oil/gm dry sample) of the three studied rape meal varieties at different pH values.

Table (2): Protein dispersibility index as a function of pH of 1% dispersion of defatted rape meal in 0.2 M NaCl.

pH	Meal of repressed varieties			L.S.D. at 5 %
	Orbal	Cresor	Brutor	
1	49.5	47.0	50.1	1.34
2	44.1	42.9	47.3	1.86
3	40.5	38.8	41.9	1.27
4	30.1	18.8	35.7	7.00
4.5	46.5	41.3	43.2	2.15
5	49.5	43.7	59.5	6.38
6	51.0	49.2	53.8	1.89
7	53.2	50.8	56.0	2.13
8	55.0	53.7	56.1	0.98
9	57.8	56.5	59.6	1.27
10	60.9	58.8	63.3	2.09

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As embodied in Figs. (1 and 2), it could be seen that EC had a positive relationship with PDI. Raising pH of emulsion above 4.5 affected markedly on increasing average EC and ES reaching their maximum at pH 9.0.

Data in Table (3) show that EC and ES were significantly affected by nature of meal protein as well as pH of the emulsion. Meal protein of variety "Orbal" characterized by highest EC and ES followed by "Brutor" and "Cresor". Maximum increasing in EC was noticed at pH 9.0 for all studied samples of rape meals. Meanwhile, ES reached its maximum at pH 7.5 for "Orbal" and "Cresor" varieties, and at pH 9.0 for "Brutor" variety. On the other side, low ES was noticed at pH 3.0. These results may be attributed to dissociate of high molecular weight molecules of proteins to subunits at acid pH (Girault, 1973).

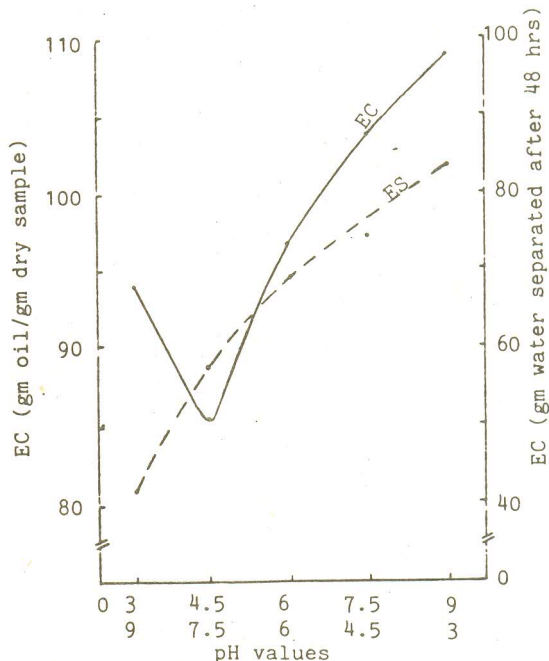


Fig. (2): Average emulsion capacity (EC) and stability (ES) of rape meal varieties as a function of pH.

Table (3): Emulsion capacity and stability as a function of pH of 1% dispersion of defatted rape meal.

Meal of rapeseed varieties	pH	Emulsion capacity (g.oil)	Vol of water separated (ml) at room temp (20°C) after time (hr)						
			0.25	0.50	1.00	2.00	3.00	24.0	48.0
Orbal :	3.0	100	4	9	20	44	61	72	74
	4.5	93	0	0	0	0	0	48	59
	6.0	105	0	0	0	0	0	22	48
	7.5	116	0	0	0	0	0	13	25
	9.0	123	0	0	0	0	0	0	27
L.S.D. at 5%		10.2							18.7
Cresor :	3.0	84	40	53	60	64	64	64	95
	4.5	76	0	0	0	8	30	82	82
	6.0	88	0	0	0	8	12	48	84
	7.5	89	0	0	0	6	10	50	74
	9.0	94	0	0	0	7	14	52	79
Brutor :	3.0	98	16	30	41	53	53	70	82
	4.5	88	0	8	8	32	44	83	83
	6.0	97	0	0	0	7	18	69	76
	7.5	109	0	0	0	4	4	35	74
	9.0	120	0	0	0	0	5	20	20
L.S.D. at 5%		11.8							23.7
L.S.D. at 5%	pH		3.0	4.5	6.0	7.5	9.0		
	EC		7.1	7.1	6.9	12.8	17.7		
	ES		8.7	11.1	15.5	23.1	26.3		

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3- Foam capacity (FC) and stability (FS):

The results in Fig. (3) and Table (4) indicate clearly that highest FC for the three rape meals and their average was obtained at pH 6.0, whereas, maximum FS after 2 hours was at pH 7.5.

As shown in Table (4), FC and FS of investigated rape meal varieties were statistically varied. The highest FC was obtained for rape meal of variety "Brutor" followed by "Orbal" and "Cresor" at all studied pH values. In opposite, rape meal of variety "Cresor" had higher FS than the other two meals except at pH 7.5 which rape meal variety "Orbal" registered the highest one.

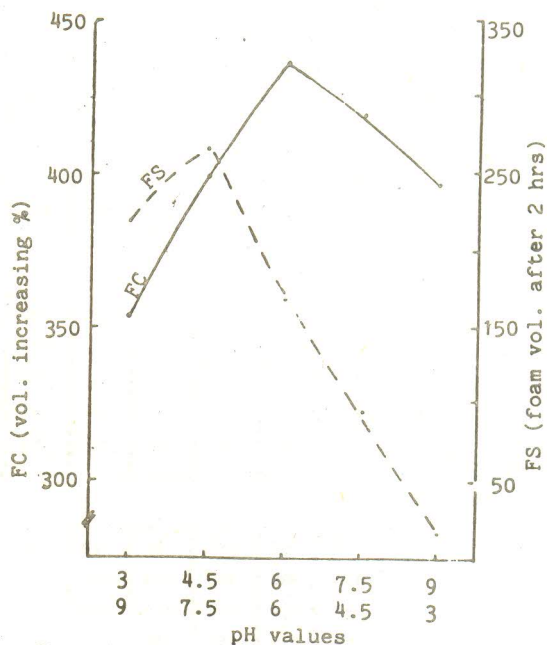


Fig. (3): Average foam capacity (FC) and stability (FS) of rape meal varieties as a function of pH.

Table (4): Foam capacity and stability as a function of pH of 1% dispersion of defatted rape meal.

Meal of rapeseed varieties	pH	Vol after whipping (ml)	Vol increasing (%)	Vol (ml) at room temperature (20°C) after time (min)									
				5	10	20	30	40	50	60	90	120	
Orbal :	3.0	462	362	243	133	79	79	59	51	51	40	tr.	
	4.5	535	435	360	260	171	171	162	146	120	90	90	
	6.0	559	459	465	465	446	422	385	313	246	132	132	
	7.5	520	420	480	480	480	480	441	441	416	373	327	
	9.0	500	400	432	432	420	420	420	395	375	240	221	
L.S.D. at 5%		42.4											
Cresor :	3.0	352	252	61	61	54	54	54	30	26	tr.	tr.	
	4.5	390	290	339	200	159	125	125	110	110	100	82	
	6.0	474	374	432	432	432	405	390	364	303	277	231	
	7.5	470	370	460	413	413	370	370	370	347	300	270	
	9.0	460	360	426	426	362	362	362	362	362	296	250	
L.S.D. at 5%		49.2											
Brutor :	3.0	550	450	461	410	369	267	166	112	95	50	50	
	4.5	572	472	500	460	380	346	258	258	127	127	113	
	6.0	574	474	472	424	424	365	316	218	175	153	143	
	7.5	565	465	492	454	454	454	346	315	270	224	212	
	9.0	530	430	434	434	434	400	265	265	244	222	195	
L.S.D. at 5%		16.4											

L.S.D. at 5% pH 3.0 4.5 6.0 7.5 9.0
 FC 81.0 78.5 44.0 38.8 28.7

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Regarding the available data in Fig. (3) it could be concluded that FC was in opposite relationship with both PDI (Fig. 1) and EC (Fig. 2). These results are close with those obtained by Mary and Barbara (1979).

4- Water and oil absorption :

Data in Table (5) revealed that defatted rape meal characterized by high water absorption, but it varied according to the genotype of rape variety. "Orbal" meal was even significantly higher in water holding capacity i.e., water absorption than "Cresor" and "Brutor" varieties. These results indicated that the insoluble proteins of defatted meal of rapeseed variety "Orbal" swell and retain more water than the other ones.

Table (5): Water and oil absorption (gm/100 gm dry sample) of rape meal of some rapeseed varieties.

Meal of rapeseed varieties	Water absorption	Oil absorption
Orbal	300	200
Vresor	275	250
Brutor	250	260
L.S.D. at 5%	21.2	26.2

The centrifugation method of assessing fat absorption measures the amount of oil physically entrapped by the protein. From the data obtained in Table (5) it could be seen that defatted rape meal of variety "Brutor" had statistically better oil absorption capacity followed by "Cresor", while "Orbal" meal was in the third position. It means that meal protein of rapeseed variety "Brutor" probably had more exposed hydrophobic groups, while "Orbal" had more hydrophylic groups. Also, the above mentioned data reflected a negative relationship between both water holding capacity and oil absorption in studied rapeseed meals.

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الخواص الكيميائية والنوعية للكسب المنزوع منه الدهن
لبعض أصناف بذور الشلجم

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تم تحضير الكسب المنزوع منه الدهن لثلاث أصناف من بذور الشلجم وهي : أوربال ، كريسور ، بروتور وذلك لدراسة الخواص الكيميائية والنوعية . وقد تميز كسب الصنف (بروتور) بارتفاع معنوي في نسبة البروتين الخام ، الكربوهيدرات الكلية ، السكريات المختزلة والالياف الخام . بينما الصنف (أوربال) كان منخفضاً في محتواه من البروتين الخام والكربوهيدرات الكلية والسكريات المختزلة والسكريات الثلاثية وكذلك DNA & RNA .

وقد كانت درجة ذوبان البروتين أقل مايمكن عند درجة حموضة قرب نقطة التعادل الكهربى وزادت زيادة معنوية عند رقم حموضة اقل أو أعلى من هذه النقطة . وتبين من النتائج ان القدرة على تكوين الرغوة على علاقة عكسية مع درجة ذوبان البروتين والقدرة الاستحلابية على درجات الحموضة المختلفة . وقد تميز كسب الصنف (بروتور) بالارتفاع المعنوي في درجة ذوبان البروتين والقدرة على تكوين الرغوة ودرجة امتصاص الزيت بمقارنته بالصنفين الآخرين ، بينما كان الصنف (أوربال) الاعلى في القدرة الاستحلابية ودرجة ثبات المستحلب وثبات الرغوة كذلك بامتصاص الماء . وتبين ان أعلى قدرة استحلابية كانت عند رقم حموضة ٩.٠ وذلك بالنسبة للثلاث أصناف المدروسة في حين كانت اعلى درجة ثبات للمستحلب عند رقم حموضة ٧.٥ للصنفين (أوربال) و (كريسور) وعند رقم حموضة ٩.٠ للصنف (بروتور) . وكانت اعلى قدرة على تكوين الرغوة للثلاث أصناف المدروسة عند رقم ٦.٠ بينما اقصى درجة ثبات للرغوة عند رقم حموضة ٧.٥ .