POLISH JOURNAL OF NATURAL SCIENCES
Abbrev.: Pol. J. Natur. Sc., Vol 27(4): 465–476, Y. 2012

IMPACT OF CONDITIONS OF RAPESEED OIL HYDRATION ON THE CONTENT AND PROFILE OF PHOSPHOLIPIDS

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K e y w o r d s: rapeseed oil, hydration, hydrated oil, oil gums, phosphorus content, phospholipids content, profile of phospholipid fraction.

A b s t r a c t

The aim of the study was to determine the impact of hydration conditions on the content of phosphorus and the content and profile of phospholipids in hydrated oils and oil gums. The experiment was carried out on industrial hot-pressed oil which was subjected to hydration reaction with different additions of water (0.5, 1.5 and 3.0%) and at different temperatures (70 and 80°C). The following parameters were determined: content of phosphorus in accordance with PN-88/A-86930 (*Tłuszcze roślinne jadalne*... PN-88/A-86930), lipid composition with column chromatography and profiles of the phospholipid fraction with thin layer chromatography. The content of phosphorus, profile of phospholipids and composition of fatty acids were measured in oil gums extracted in the hydration process.

It was found that the content and profile of phospholipids in hydrated oils significantly depended on the conditions during hydration and the dose of water was a more differentiating factor than the temperature of the hydration reaction. The greatest degree of phospholipid removal was recorded during hydration of oil with 0.5% water at 70°C. The oils hydrated with 3.0% water at both temperatures showed the lowest degree of phospholipid removal and the extracted oil gums had the lowest content of phosphorus and noticeable residues of oil. The impact of hydration conditions on the profiles of phospholipids in hydrated oils, oil gums and the composition of fatty acids was minimal. Phosphatidylcholine and phosphatidylinositol were the most hydratable phospholipids because of the highest degree of their removal during hydration.

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WPŁYW WARUNKÓW HYDRATACJI NA ZAWARTOŚĆ FOSFORU I UDZIAŁ FOSFOLIPIDÓW W OLEJACH RZEPAKOWYCH I ŚLUZACH POHYDRATACYJNYCH

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S ł o w a k l u c z o w e: olej rzepakowy, hydratacja, olej hydratowany, śluzy, zawartość fosforu, udział fosfolipidów, profil fosfolipidowy, skład kwasów tłuszczowych.

A b s t r a k t

Celem badań było określenie wpływu warunków hydratacji na zawartość fosforu oraz udziału i profilu fosfolipidów w olejach hydratowanych laboratoryjnie i otrzymanych śluzach. Badano przemysłowy olej tłoczony na gorąco poddany hydratacji różnymi dodatkami wody (0,5, 1,5 i 3,0%). Proces prowadzono w temperaturach 70 i 80°C. W olejach określono: zawartość fosforu – metodą wg PN-88/A-86930, (*Tłuszcze roślinne jadalne...* PN-88/A-86930) skład lipidowy – metodą chromatografii kolumnowej oraz profile fosfolipidowe – metodą chromatografii cienkowarstwowej. W śluzach pohydratacyjnych oznaczono zawartość fosforu, profil fosfolipidowy oraz skład kwasów tłuszczowych.

Stwierdzono, iż udział i profil fosfolipidów olejów hydratowanych istotnie zależał od warunków hydratacji, przy czym dawka wody była bardziej różnicującym czynnikiem niż temperatura hydratacji. Największy stopień usunięcia fosforu uzyskano, prowadząc hydratację 0,5% dodatkiem wody w temperaturze 70°C. Oleje hydratowane 3,0% dodatkiem wody w obu temperaturach hydratacji cechowały się najwyższą zawartością fosforu i udziałem fosfolipidów, a śluzy z nich wydzielone – najniższą zawartością fosforu. W dwuczynnikowej analizie wariancji wykazano, iż przyjęte warunki hydratacji miały różny wpływ, aczkolwiek niższy, na kształt profili fosfolipidowych oraz skład kwasów tłuszczowych niż na stopień usunięcia fosforu. Hydratacja w największym stopniu usunęła fosfatydylocholinę i fosfatydyloinozytol, co świadczy o ich przynależności do fosfolipidów hydratowalnych.

Introduction

Crude rapeseed oil is mainly composed of triacylglycerols and minor amounts of non-triacylglycerol compounds such as phospholipids, free fatty acids, sterols, tocopherols, pigments, flavonoids and glycolipids. Phospholipids generate many technological problems during the production of rapeseed oil and therefore they should be removed to the highest degree possible (SZYDŁOWSKA-CZERNIAK 2007).

During processing of rape seeds and oil pressing, phospholipids are released due to physical, thermal or enzymatic degradation of membranes and they freely migrate to extracted oil (PRIOR et al. 1991, NIEWIADOMSKI 1993, SZWED and TYS 1995a,b). Oils with a high content of phospholipids are turbid, with worse colour, taste and smell and have a shorter shelf-life (SIMPSON 1991, SUBRAMANIAN et al. 1999, HAFIDI et al. 2005, KORIS and MARKI 2006, YANG et al. 2006). A higher content of phosphorus in oils subjected to acid degumming

impairs the course of further refining processes and/or oil modification (UNGER 1990, SUBRAMANIAN and NAKAJIMA 1997, JERZEWSKA et al. 2001, VAN GERPEN 2005, PŁATEK 2009).

From a technological point of view, phospholipids (PL) are divided into hydratable (HF) and non-hydratable (NHF) compounds. Phospholipids such as PC, PI and lysoPL are easily hydratable. PE is partially hydratable, whereas PA is classified as non-hydratable (SUBRAMANIAN et al. 1999, ZUFAROV et al. 2009). Free PA is created as a result of phospholipase D activity but, due to the presence of free metal ions (calcium and magnesium) in oils, it forms non-hydratable salts with them. Two-phase degumming is commonly implemented in industry, with preliminary degumming (water degumming, hydration) is carried out in an extracting facility and primarily relates to extracting oil immediately after solvent evaporation. Such extracted oil is mixed with raw pressed oil and then it constitutes crude oil for the refining process which, according to PN-87/A-86906 (*Tłuszcze roślinne jadalne...* PN-87/A-86906), may contain up to 200 ppm phosphorus. The so-called "terminal degumming" is the first stage of oil refining process and consists of removing non-hydratable phospholipids with the use of mineral or organic acids (NIEWIADOMSKI 1993, PRZYBYLSKI et al. 2005). The parameters of hydration presented in the literature are ambiguous: the doses of water reported by authors range from 0.5 to 5.0% and the temperature of hydration is between 70 and 90°C (ALY 1991, INDIRA et al. 2000, ESHRATABADI et al. 2008, ZUFAROV et al. 2008). Few publications have discussed the impact of hydration conditions on the content and profile of phospholipids in oils and oil gums and the composition of fatty acids.

It was therefore assumed to determine the impact of hydration conditions on the content and profile of phospholipids in oils and extracted oil gums.

Materials and Methods

Description of study material

The study was carried out on a sample of industrial hot-pressed rapeseed oil that originated from Oleochemical Plant BIELMAR in Bielsko-Biała, Poland. The oil was extracted from seed mash conditioned at 110–112°C for 30 minutes and then pressed at 110–120°C.

Hydration of oils

Redistilled water at 0.5, 1.5 and 3.0% in relation to a weighted portion of oil was added to oil heated to 70/80°C and the hydration process was then carried out for 15 minutes. Hydration was performed on electromagnetic stirrers (rotation velocity = 250 rpm) with a constant sample temperature. Post-hydration gums were removed from oil by centrifuging (10 min/1000 rpm).

Methods

The phosphorus content (*Tłuszcze roslinne jadalne*... PN-88/A-86930), the composition of lipids with column chromatography (OHM and CHUNG 1999) and the profiles of phospholipids with thin layer chromatography (NAZI and PROCTOR 1998) were determined.

Determination of lipid composition in oils. The measurement was carried out in MEGA BOND SI 1GM 6ML columns. The flow of solvent through the columns was forced at a negative pressure of 18 kPa in a BAKER SPE-12 G chamber. In the first stage, the column was conditioned with 5 ml chloroform. The sample was prepared by dissolving the extract of lipids in 25 ml of chloroform and then, depending on the sample, 10 ml of such solution was placed on a column. Lipids were fractionated by gradual washing with proper solvents. Fractions of non-polar lipids (NPL) were washed away with 10 ml chloroform: acetone mixture (4:1), glycolipids (GL) with 15 ml acetone: methanol mixture (9:1) and phospholipids (PL) with 10 ml methanol. Following fractioning, the solvents were evaporated in a VI-PAR-type 350 vacuum evaporator at 50°C and lower pressure and the samples were then weighed.

Determination of phospholipid profiles. The measurements were carried out on 20 x 20 cm MERCK chromatographic plates with silica gel. The plates were conditioned in a drier at 105°C for 1 h. The chromatographic chamber was saturated with a mixture of solvents (chloroform: methanol: water = 75: 25: 3). The previously-extracted phospholipid fractions and phospholipid SIGMA standards (phosphatidylcholine, phosphatidylethanolamine, phosphatidylinositol, phosphatidylserine, lysophosphatidylcholine, phosphatidic acid) weighing app. 25 μg were placed on the plates. The plates were then put into a chromatographic chamber and the chromatograms were stained in iodine atmosphere and then scanned in order to process the results. Treatment of the results was carried out using a densitometry method, involving the measurement of the intensity of spots using the TLC Chromatograf v 1.0 program.

The extracted oil gums were characterized by measuring the content of phosphorus with the method described above, the profiles of phospholipids (as described above) and composition of fatty acids (*Analiza estrów metylowych*... PN-EN ISO 5508:1996) by preparing methyl esters according to ZADERNOWSKI and SOSULSKI (1978). The separation of methyl esters was performed with GC 8000 series, FISONS Instrument, gas chromatograph with the use of flame ionization detector and a packed-column type-DB-225 (30 m x 0.25 mm) filled with chromosorb GP. Helium was the carrier gas. Fatty acids were identified based on retention times determined for standards.

The oil gums extracted from hydrated oils were photographed with an array for digital image analysis that included a Nikon DXM 1200 digital camera, a KAISER RB HF light source (consisting of 4 fluorescent 36W lamps with a colour temperature of 5400°K), a computer with an image acquisition card compatible with a DXM 1200 digital camera, LUCIA G Wer. 4.80 software, a computer display and a printer (TAŃSKA 2005).

Statistical analysis

The results of the study were statistically analysed with Statictica 9.0 PL software (StatSoft Poland). One-way analysis of variance (ANOVA), together with Tukey's test with a critical significance level at $p=0.05$ were performed to find the significance of differences between the oil samples. The impact strength of tested factors on the content of phosphorus, content and profile of phospholipids and composition of fatty acids was determined with a two-way analysis of variance.

Results

The content of phosphorus in the tested oil was 209.9 mg kg^{-1} (Table 1). Hydration of this oil carried out at both temperatures with 0.5 and 1.5% water resulted in a similar degree of phospholipid removal (> 70%). The lowest efficacy was reported during the hydration process with 3.0% water when the degree of phospholipid removal was only 11.2% (70°C) and 13.1% (80°C) – Table 1.

The content of phosphorus in the extracted oil gums in the conditions of hydration of oils was significantly diversified (Table 1). The highest content of phosphorus was detected in the oil gums extracted during oil hydration with 0.5% water, while the lowest content was with 3.0% water (Table 1). The diversification of oil gum parameters is seen in the photographs (Figure 1). The photographs taken on a light background indicate the colour of oil gum fractions, whereas on a dark background they reveal the structure of oil gums

Table 1

Content of phosphorus [mg kg^{-1}] in hydrated oils and post-hydration oil gums

Conditions of hydratation	Hydrated oils		Post-hydration oil gums
	content of phosphorus [mg kg^{-1}]	degree of removal of phospholipids [%]	content of phosphorus [mg kg^{-1}]
Crude oil	$209.9^{d} \pm 6.88$	–	–
70°C/0.5%	$53.6^{a} \pm 0.62$	74.5	$13982^{d} \pm 68$
70°C/1.5%	$61.1^{b} \pm 1.56$	71.4	$8129^{b} \pm 34$
70°C/3.0%	$186.4^{c} \pm 4.02$	11.2	$5051^{a} \pm 50$
80°C/0.5%	$55.8^{a} \pm 0.97$	73.4	$12013^{c} \pm 90$
80°C/1.5%	$58.3^{ab} \pm 1.18$	72.2	$8802^{b} \pm 81$
80°C/3.0%	$182.4^{c} \pm 1.32$	13.1	$5120^{a} \pm 40$

a,b... – mean values in columns marked with the same letter are not significantly different ($p \leq 0.05$)

placed on a thin layer. Because of the close similarity between the photographs of oil gums taken at both hydration temperatures, only the images of oil gums taken at 80°C are presented in this publication (Figure 1). The oil gums extracted from hydrated oil with the lowest dose of water (0.5%) were darker (Figure 1a) than the oil gums formed during hydration with higher water doses, which had a lighter colour due to oil residues (Figure 1c, 1e). The structure of oil gums extracted with 0.5% water was more compact (Figure 1b) than the texture of oil gums extracted with 1.5 and 3.0% water (Figure 1d, 1f).

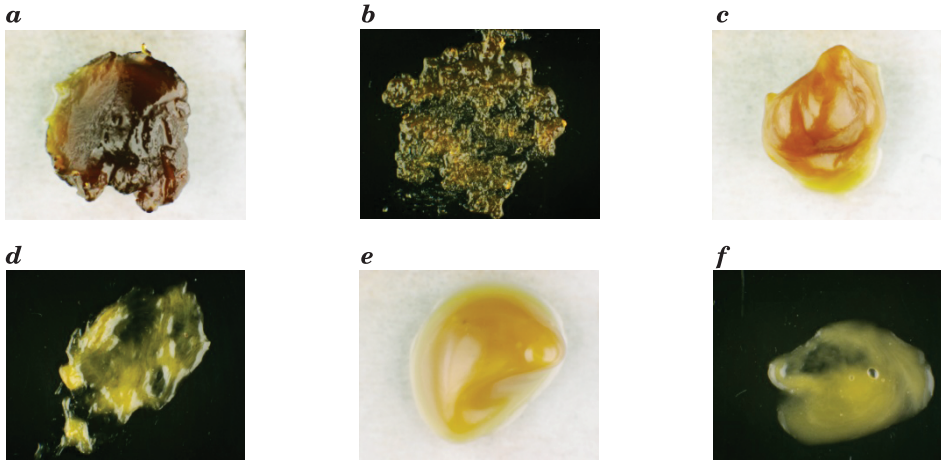

Fig. 1. Oil gums extracted during hydration of oil at 80°C with different water doses; where: *a, b* – 0.5% water, *c, d* – 1.5% water, *e, f* – 3.0% water

Non-polar lipids were predominant in the composition of initial oil and the content of phospholipids was 0.73% (Table 2). The oils hydrated with different doses of water had a lower content of phospholipids. The oil hydrated with 0.5% water had the lowest concentration of phospholipids (0.27% at 70°C and 0.30% at 80°C) which indicated the largest degree of their removal. Together with the increase in water doses, the efficacy of hydration process decreased – which was confirmed by the higher content of phospholipids in the oils (Table 2).

The profile of phospholipids in raw oil consisted of PC, PI, PE and PA. The most evident changes during oil hydration were reported in the content of PE which increased from 21.88% (non-hydrated oil) to 64.22% in the oil hydrated with 0.5% water at 70°C (Table 2). The content of PI decreased from 29.13% to 11–15%, except for the oil hydrated at 70°C with 0.5% water in which it amounted to 4.37%. The concentration of PC in the hydrated oils was lower than in the initial oil. The impact of varied water doses was noted only in the case of oils hydrated at 70°C, in which the content of PC ranged from 18.62% in the oil hydrated with 0.5% water to 30.92% in the oil hydrated with 3.0% water. The concentration of PA remained virtually unchanged in all oils hydrated at 80°C and it was increased only in the oils hydrated at 70°C with lower (0.5 and 1.5%) doses of water (Table 2).

Three phospholipids (PC, PI and PE) were detected in post-hydration oil gums (Table 2). PC was the predominant phospholipid and its content in all samples of oil gums, regardless of hydration conditions, ranged between 49.01 and 52.57%. PE was the second-most abundant phospholipid and its content ranged from 24.57% to 30.15% in the oil gums formed following hydration with 1.5% water at 80°C and 70°C. The other samples of oil gums were not varied in their PE content (Table 2). The concentration of PI in the majority of oil gum samples was not statistically different (Table 2). The shape of phospholipid profiles in the oil gums, whose PC and PI concentrations were significantly higher and PE content was much lower than in the hydrated oils, confirms that PC and PI are hydratable phospholipids, while PE is classified as a non-hydratable phospholipid.

The composition of fatty acids in the initial oils was typical of rapeseed oil (Table 3). The samples of oil gums obtained under different hydration conditions differed significantly in the content of fatty acids in comparison with the initial oil. In general, it was found that the hydrated oils had a lower content of oleic acid (54–57% vs. 62.34%) and linolenic acid (6–8% vs. 9.34%), whereas the concentrations of linoleic (24–28% vs. 19.67%) and palimitic (8–10% vs. 4.97%) acids were higher (Table 3).

Table 2

Composition of lipid fraction and profiles of the phospholipid fraction of hydrated oils and post-hydrated oil gums

Conditions of hydratation	Hydrated oils							Post-hydrated oil gums		
	lipid composition [%]			phospholipid profile [%]				phospholipid profile [%]		
	NPL	GL	FL	PC	PI	PE	PA	PC	PE	PI
Crude oil	$98.86^{a*} \pm 0.06$	$0.42^{c} \pm 0.07$	$0.73^{d} \pm 0.02$	$39.83^{d} \pm 0.68$	$29.13^{e} \pm 1.13$	$21.88^{a} \pm 0.79$	$8.47^{abc} \pm 0.75$	–	–	–
70°C/0.5%	$99.39^{c} \pm 0.01$	$0.34^{a} \pm 0.03$	$0.27^{a} \pm 0.01$	$18.62^{a} \pm 0.38$	$4.37^{a} \pm 0.08$	$64.22^{d} \pm 0.59$	$12.79^{d} \pm 1.05$	$49.01^{a} \pm 0.27$	$27.71^{ab} \pm 1.02$	$23.29^{bc} \pm 0.77$
70°C/1.5%	$99.32^{b} \pm 0.01$	$0.31^{ab} \pm 0.04$	$0.37^{b} \pm 0.03$	$24.16^{b} \pm 1.96$	$15.37^{d} \pm 0.18$	$47.58^{bc} \pm 1.24$	$12.94^{d} \pm 0.91$	$49.24^{ab} \pm 2.21$	$30.13^{b} \pm 3.39$	$20.63^{ab} \pm 1.24$
70°C/3.0%	$98.99^{a} \pm 0.05$	$0.35^{a} \pm 0.05$	$0.67^{c} \pm 0.01$	$30.92^{c} \pm 0.88$	$14.75^{cd} \pm 1.06$	$47.13^{b} \pm 0.11$	$7.19^{a} \pm 0.29$	$51.72^{ab} \pm 0.46$	$29.35^{ab} \pm 0.94$	$20.69^{ab} \pm 2.03$
80°C/0.5%	$99.45^{c} \pm 0.05$	$0.25^{a} \pm 0.01$	$0.30^{a} \pm 0.02$	$28.23^{ab} \pm 1.31$	$12.82^{bc} \pm 0.26$	$49.03^{bc} \pm 1.37$	$9.92^{c} \pm 0.33$	$50.76^{ab} \pm 1.96$	$25.20^{ab} \pm 2.36$	$24.48^{c} \pm 0.24$
80°C/1.5%	$99.40^{b} \pm 0.03$	$0.26^{ab} \pm 0.04$	$0.33^{b} \pm 0.01$	$27.93^{bc} \pm 1.29$	$11.94^{b} \pm 0.93$	$50.90^{bc} \pm 2.40$	$9.23^{bc} \pm 0.18$	$52.57^{b} \pm 0.36$	$24.57^{a} \pm 0.92$	$22.87^{bc} \pm 1.23$
80°C/3.0%	$98.86^{a} \pm 0.09$	$0.49^{bc} \pm 0.09$	$0.65^{c} \pm 0.01$	$29.92^{c} \pm 1.60$	$10.94^{b} \pm 0.66$	$51.45^{c} \pm 1.54$	$7.68^{ab} \pm 0.72$	$51.56^{ab} \pm 0.51$	$29.08^{ab} \pm 1.17$	$19.36^{a} \pm 1.31$

a,b... – mean values in columns marked with the same letter are not significantly different ($p \leq 0.05$)

Table 3

Fatty acid composition of post-hydrated oil gums

Conditions of hydratation	Fatty acid [%]					
	$C_{16:0}$	$C_{18:0}$	$C_{18:1}$	$C_{18:2}$	$C_{18:3}$	
Crude oil	$4.97^{a} \pm 0.07$	$1.52^{e} \pm 0.01$	$62.34^{e} \pm 0.01$	$19.67^{a} \pm 0.04$	$9.34^{e} \pm 0.05$	2.14 ± 0.18
70°C/0.5%	$8.72^{b} \pm 0.59$	$1.19^{a} \pm 0.06$	$56.94^{b} \pm 0.03$	$26.46^{c} \pm 0.69$	$6.69^{c} \pm 0.07$	trace
70°C/1.5%	$8.25^{b} \pm 0.70$	$1.14^{a} \pm 0.06$	$57.22^{b} \pm 0.91$	$26.91^{cd} \pm 0.05$	$6.48^{bc} \pm 0.11$	trace
70°C/3.0%	$10.15^{c} \pm 0.45$	$1.63^{d} \pm 0.06$	$54.61^{a} \pm 0.95$	$27.53^{d} \pm 0.06$	$6.08^{ab} \pm 0.50$	trace
80°C/0.5%	$8.45^{b} \pm 0.10$	$1.91^{e} \pm 0.18$	$57.37^{b} \pm 0.08$	$24.43^{b} \pm 0.42$	$7.84^{d} \pm 0.06$	trace
80°C/1.5%	$9.12^{bc} \pm 0.47$	$1.38^{b} \pm 0.05$	$57.11^{b} \pm 0.28$	$26.55^{c} \pm 0.54$	$5.84^{a} \pm 0.30$	trace
80°C/3.0%	$10.08^{c} \pm 0.72$	$1.28^{ab} \pm 0.04$	$55.37^{a} \pm 0.81$	$27.52^{d} \pm 0.18$	$5.75^{a} \pm 0.05$	trace

a,b... – mean values in columns marked with the same letter are not significantly different ($p \leq 0.05$)

Table 4

Coefficients of significance (F) determined with two-way analysis of variance for hydrated oils and post-hydration oil gums

Discriminant		Factor of variance		
		hydration temperature	addition of water	hydration temperature x addition of water
Hydrated oils	content of phosphorus [mg kg^{-1}]	6*	16867**	8**
	share of phospholipids [%]	7*	2313**	20**
	share of PC in phospholipid fraction [%]	87**	85**	47**
	share of PI in phospholipid fraction [%]	n.s.	209**	344**
	share of PE in phospholipid fraction [%]	25**	105**	187**
	share of PA in phospholipid fraction [%]	97**	146**	25**
Post-hydration oil gums	content of phosphorus [mg kg^{-1}]	361**	45236**	1375**
	share of PC in phospholipid fraction [%]	n.s.	8*	n.s.
	share of PE in phospholipid fraction [%]	10**	n.s.	n.s.
	share of PI in phospholipid fraction [%]	n.s.	14**	n.s.
	share of stearic acid [%]	n.s.	29**	n.s.
	share of palmitic acid [%]	44**	34**	106**
	share of oleic acid [%]	n.s.	45**	n.s.
	share of linoleic acid [%]	35**	81**	21**
	share of linolenic acid [%]	n.s.	104**	45**

* – significant impact of factor at $p \leq 0.05$
** – significant impact of factor at $p \leq 0.01$
n.s. – not significant

Statistical analysis. A two-way analysis of variance revealed that the content of phosphorus in oils (F=16867) and oil gums (F=45236) depended to the largest extent on the amount of water used for hydration and the relationship between this factor and hydration temperature (F=1375). The impact of hydration temperature on the concentration of phosphorus in the hydrated oils (F=6) and oil gums (F=361) was minimal (Table 4). The content of phospholipid fraction in the hydrated oils depended more on a water dose (F=2313) than hydration temperature (F=7) (Table 4). In addition, the two-way analysis of variance showed that the impact of hydration condition on the shape of phospholipid profiles in hydrated oils and oil gums was minimal, which was further confirmed by the values of coefficient significance: F=25–209 for oils and F=10–104 for oil gums (Table 4).

Discussion

The analysis of the impact of hydration conditions of rapeseed oil (70/80°C x 0.5; 1.5; 3.0% water) showed that the degree of phospholipid removal decreased with an increase in water. The best results were achieved when the hydration process was performed with 0.5% water at 70°C. The oil hydrated under these conditions had the lowest content of total phosphorus and the lowest concentration of phospholipids and the extracted oils gums contained the highest amount of phosphorus. INDIRA et al. (2000) carried our hydration of rice oil, which contained 1.8% phospholipids, with varied water doses (0.5–4.0%) and at different temperatures (26–90°C) and found that the optimal performance of the process was effectuated with 4.0% water at 68–73°C. Hydration under these conditions yielded the highest (80%) degree of removal of phospholipids. The results of the above cited publication differ from our studies in which higher doses of water (1.5%, 3.0%) reduced the amount of extracted phosphorus. It was also found that the oils hydrated with 3.0% water were turbid following centrifugation and water droplets were visible after resting. The extracted oil gums had a looser, oily texture and a lighter colour, which might be related to the increased content of oil and water droplets (Fig. 1). PŁATEK (1998) reported that the amount of water supplied in the hydration process should approximate the percentage of phospholipids. An insufficient amount of water results in incomplete hydration, whereas its excessive volume generates the formation of a 3-phase system consisting of water, oil gums and turbid oil. INDIRA et al. (2000) reported after List et al. that extracted oil gums may undergo re-hydration and be reintroduced into oil phase, especially during long-lasting stirring. ESHRATABADI et al. (2008) reported that the

dose of water used in degumming of crude vegetable oils should be experimentally determined.

SOSADA et al. (2003) analysed the composition of industrial rapeseed lecithin and showed that it contained 63% of substances which were non-soluble in acetone, including 15% PC, 25% PE, 35% PI and other compounds such as lysophospholipids, glycolipids, sterols and carbohydrates. VAN NIEUWENHUYZEN and MABEL (2008) examined the composition of liquid rapeseed lecithin and reported that PC was the predominant phospholipid and it amounted to 17%, whereas PI, PE and PA constituted 10, 9 and 4% of lecithin, respectively.

Conclusions

1. The content and profile of phospholipids in hydrated oils significantly depended on hydration conditions and the dose of water was a more differentiating factor than hydration temperature.

2. The most effective oil hydration was carried out with 0.5% water at 70°C since it reduced the content of phospholipids to the highest degree.

3. The oils hydrated with 3.0% water at both temperatures had the lowest degree of phospholipid removal and the extracted oil gums had the lowest content of phosphorus and visible oil residues.

4. The impact of hydration conditions on the shape of phospholipid profiles in hydrated oils and oil gums and on the composition of fatty acids was minimal.

5. Phosphatidylcholine and phosphatidylinositol were the most hydratable phospholipids because of the highest degree of their removal during hydration.

Translated by JOANNA JENSEN

Accepted for print 8.10.2012

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