Determining the Feeding Value of some Food Industry By-Products

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Abstract

Food industry by-products can be used in dairy cows feeding on condition they have suitable feeding value. A complex physical-chemical study was conducted on seven plant by-products (wheat germs meal, sunflower meal, flaxseed meal, pumpkin meal, nuts meal, rosehip meal and grape meal) to determine their feeding value. These by-products have variable protein contents: between 10.86% in rosehip meal and 39.34% in the flaxseed meal), and different contents of amino acids, lysine particularly: 2.09% (wheat germs meal); 1.72% (pumpkin meal) and 1.04% (sunflower meal). The highest concentration of linolenic acid was determined in the flaxseed meal (68.57 g/100 g total fatty acids), which also had the highest level of digestible energy (18.16 MJ/kg) and the highest amount of intestinally digestible protein allowed by the energy content (118 g PDIE/ kg DM). The flaxseed meal also had the highest amount of milk feed units (1.45 FU_{milk}/kg DM) and of meat feed units (1.48 FU_{meat}/kg DM) among all studied by-products. The results of these analyses show that the surveyed by-products can be used to feed ruminant animals.

Keywords: by-products, feeding value, digestible energy, milk feed units, meat feed units

1. Introduction

Nutrition is essential for animal productivity. A balanced diet consists of water, energy, protein, minerals and vitamins, in varying proportions depending on the animals, the environmental and management factors [1]. There is a wealth of interests for natural products and healthy foods that can improve animal welfare, disease prevention and also for the incorporation of substances that promote health in the diet as natural food additives. Secondary feeds provide valuable nutrients to the diets and allow their use as feed instead of being treated as waste [2]. Many of these by-products offer a considerable amount of protein, fibre, fat and minerals in diets [3]. Among the oil extraction industry by-products, meals are vegetable raw materials that can be used in animal feed. These are very diverse products, with complex composition and rich in particular nutrients. Sunflower sprout is a by-product of the edible oil industry. It is a rich source of vegetable proteins and other nutrients such as crude protein, ether extract, crude fibre and ash [4]. Wheat germ meal is a major by-product of the wheat grinding industry being considered a natural source of highly concentrated nutrients [5]. Flax meal has an increased concentration of polyunsaturated fatty acids, of which 53% is alpha linolenic acid [6]. When included in dairy cow feeds, it can improve productive performance [7]. Pumpkin meal is rich in dietary fibre represented by food components resistant to hydrolysis of human digestive enzymes. These fibres are needed to promote good

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health [8]. Walnut meal has key nutrients such as proteins, lipids and fibre, which are extremely variable because their nutritional value depends on the extraction process. With regard to rosehip meal, there are numerous studies on its use in veterinary and human therapy. The physiological properties of fruits are mainly attributed to their high phenols, phenols having a broad spectrum of biochemical activities such as antioxidant, antimutagenic, and anti-carcinogenic effects [9]. Grape seed is a by-product of wine-vineyard production, consisting of seeds, stems and skins representing up to 20% of the weight of processed grapes [10]. Flavonoids are a broad class of polyphenolic compounds that are supposed to be important in vascular protection [11]. Tannins from grape seed extracts have a gastric protective activity [12]. Coverage of the ruminal epithelium can prevent toxins from invading blood as a positive effect on health and production, especially for the lactation of cows at risk of acidosis [12].

Purpose of the experiment: Starting from the necessity to use low input forages in ruminants feeding, we aimed to determine the feeding value of food industry by-products (meals) by ascertaining their chemical composition.

2. Materials and methods

Seven types of meals (wheat germs meal, sunflower meal, flaxseed meal, pumpkin meal, walnut meal, rosehip meal and grape meal) were analysed in terms of their chemical composition. All seven meals come from the same producer of edible oils. The basic chemical composition analyses (dry matter, protein, fat, ash), the fatty acids, amino acid and organic matter were determined on samples dried at 65ºC.

Standardized methods complying with Regulation (CE) 152/2009 (Sampling and analytical methods for the official inspection of feeds) and ISO standards were used to determine the nutrient concentration. The dry matter (DM) was determined with the gravimetric method according to Regulation (CE) nr. 152/2009 and standard SR ISO 6496:2001; the crude protein (CP) was determined by the Kjeldahl method according to Regulation (CE) nr. 152/2009 and standard SR EN ISO 5983-2:2009; the crude fat (EE) was determined by extraction in organic solvents - the method complies with Regulation (CE) nr. 152/2009 and standard SR EN ISO 6492:2001; the crude fibre was determined by the method with intermediary filtration, according to Regulation (CE) nr. 152/2009 and standard SR EN ISO 6865:2002. The amino acids were determined by high performance liquid chromatography (HPLC) after sample derivation with OPA reagent OPA (ortho-phthalaldehyde) and detection at 338 nm. We used a chromatographic *HPLC Surveyor Plus system fitted with* PDA *detector*, Hypersil BDS C18 column with silicagel, dimensions 250 4.6 mm, particle size 5 µm, with inverse phase, rotavapor R-205; The fatty acids were determined by gas chromatography, according to SR CEN ISO/TS 17764 -2: 2008, using a Perkin Elmer Clarus 500 chromatograph, fitted with a system for injection into the capillary column, with high polarity stationary phase (BPX70: 60m x 0.25mm inner diameters and 0.25µm thick film); or high polarity cyanopril phases, which have similar resolution for different geometric isomers (THERMO TR-Fame: 120m x 0.25mm ID x 0.25µm film). Determination of insoluble substances in neutral detergent solutions (NDF) and insoluble substances in acidic detergent solutions (ADF) was performed by the method of Van Soest according to SR EN ISO 16472: 2006 and SR EN ISO 13906: 2008 respectively, having the principle of successive hydrolysis with neutral detergent (NDF) solutions or acidic detergent solutions (ADF). The gross energy was determined by calculation from the gross chemical composition (dry matter, protein, fibre, fat, nitrogen-free extractives and ash) using the equations of [13]. After determining the primary chemical composition of the studied by-products, we made determinations and calculations regarding the digestibility of the organic substance (dSO) and the protein quality with the two forms of PDIN (intestinal digestible protein nitrogen basis) and PDIE (intestinal digestible protein on energy basis). dSO was determined by an in vitro digestibility assay [14]. The expression of the net energy for meat production (ENC) and of the net energy for milk production (ENL) was calculated comparative to the oats used as standard, in milk feed units (FU_{milk}) and meat feed units (FU_{meat}). In expressing the protein potential of ruminant feed resources, the calculation formulas used by French researchers [15] as in the system of INRA were used to determine PDIN and PDIE respectively.

$$\text{PDIN}\left(\frac{g}{kgDM}\right) = PDIA\left(\frac{g}{kgDM}\right) + PDIMN\left(\frac{g}{kgDM}\right)$$

$$\text{PDIN}\left(\frac{g}{kgDM}\right) = PDIA\left(\frac{g}{kgDM}\right) + PDIME\left(\frac{g}{kgDM}\right)$$

The analytical results have been compared with the variance analysis (ANOVA), with WINDOWS StatView (SAS, version 6.0).

3. Results and discussion

The basic chemical analysis of the dietary by-products (Table 1) revealed a variable protein level in the flaxseed meal and rosehip meal. The highest crude protein level was determined in the flaxseed meal (393.54 g PB/kg DM) while the rosehip meal showed the lowest protein level (108.61 g PB/kg DM). Also, the rosehip meal had the lowest fat content (46.65g/kg DM) compared to sunflower meal (162.83 g/kg SU) and pumpkin meal (155.06 g/kg DM) (122.98 g/kg DM). The values from Table 1 are in agreement with the literature data, although the by-products have a lower level of chemical composition stability. The grape pomace had 89.92% dry matter, 12.33% crude protein and 35.17% crude fibre [16]. Also, [2] found that the flaxseed meal had 20.91% crude protein and 7.18% crude fibre and for the pumpkin meal had 87.67% dry matter, 34.88% crude protein and 27.54% crude fibre. [17] find that the rosehip powder had 92.37% dry matter, 10.53% crude protein and 49.35% crude fibre [18]. The sunflower meal had crude protein: 30.51%; ether extractives: 0.41%; crude fibre: 18.51% and ash: 10.20% [4]. For the walnut meal, the chemical composition values vary depending on the oil process extraction. Thus, [19] reported different values for cold-pressed walnuts, characterized by a high fat content (20%) and an average protein content (32%), while the compost obtained by hot pressing showed a higher amount of protein (37%). Others [20] showed that the walnut meal obtained using an American procedure was low in proteins (13-17%) and lipids (6-10%), but high in fibre (27-33%). Table 1 data show that the walnut meal is a feed ingredient also rich in crude protein (37.91% CP), with moderate level of gross energy (21.43 MJ ME). It also is a rich source of fats (12.37% EE). Similar results for walnut meal were obtained by [21].

The sunflower meal was relatively high in NDF content (480.65 g/kg DM) and ADF (310.58 g/kg DM), while the flaxseed meal had the lowest content of NDF (220.81 g/kg DM) and ADF (120.81 g/kg DM). Our results are in agreement with [22]. They obtained a similar content of NDF (566 g/kg DM) and ADF (359 g/kg DM) from sunflower meal. The chemical composition of the analysed by-products allowed them to be integrated into the feed formulations for animal feeding, resulting in increased feed quality by intake of vitamins, minerals, fatty acids, etc. Thus, some researchers [23] showed that by using pumpkin meal in dairy cow's feed, their nutrient content can be improved. [24] reported that sunflower meal is particularly useful in diets where additional protein is required in low-fodder feed with low quality. However, the most recommended by-product to improve the quality of milk is the flaxseed meal. [25] and [26] reported that by using extruded flaxseed, the linolenic acid content increased in serum from blood and milk. In addition, the inclusion of tannin based on flaxseed oil in ruminant rations can be an effective approach to attenuating the biohydrogenation of polyunsaturated fatty acids [27]. However, dietary fat [28] or tannins may have harmful effects on bacterial taxa in the rumen or affect the performance of animal production [29].

To demonstrate the biological value of the plant by-product protein, the amino acid profile, expressed per 100 g dry substance at 650C, was determined (Table 2). The profile of amino acids was extremely varied. Table 2 shows that the highest level of methionine was found in the flaxseed meal (0.509 g/100g DM), while the wheat germ meal had the highest level of lysine (2.099 g/100g DM). The lowest level of methionine was found in grape seed meal (0.181 g/100g DM), while rosehip meal had the lowest lysine content (0.242 g/100g DM). The data shown in Table 2 are comparable with the literature data for the sunflower meal [22]; flax meal [30]; grape seeds meal [31; 32]; and pumpkin meal [33].

Table 1. Basic chemical composition of the studied by-products

Item	DM	OM	CP	EE	CF	NFE	Ash	NDF	ADF	GE
	g/kg	g/kg DM								MJ/kg DM
Sunflower meal	909.15	948.33	252.66	162.83	324.03	208.81	51.67	480.65	310.58	22.44
Wheat germ meal	877.11	949.30	340.06	125.47	103.04	380.72	50.70	170.96	80.83	21.78
Flaxseed meal	907.16	950.30	393.54	122.98	83.34	350.44	49.70	220.81	120.81	21.72
Pumpkin meal	920.00	942.73	379.16	155.06	344.13	64.38	57.27	450.29	310.13	23.05
Walnut meal	907.87	944.07	345.94	123.75	226.97	247.41	55.93	340.12	220.42	21.43
Rosehip meal	904.65	975.56	108.61	46.65	558.46	261.84	24.44	670.34	500.36	20.11
Grapeseed meal	894.52	968.43	142.09	52.35	460.18	313.81	31.57	630.06	530.66	20.08

*Where: DM=dry matter; OM=organic matter; CP=crude protein; EE=ether extractives; CF=crude fibre; NFE=nitrogen-free extractives; NDF=neutral detergent fibre, ADF=Acid detergent fibre, GE=gross energy;

Table 2. Amino acids profile in the plant by-products (average values, g/100 g dry matter)

Item	Sunflower meal	Wheat germ meal	Flaxseed meal	Pumpkin meal	Walnut meal	Rosehip meal	Grapeseed meal
Aspartic acid	2.678	3.883	4.234	3.864	3.686	1.207	1.299
Glutamic acid	5.711	6.368	8.652	7.055	7.410	3.010	3.541
Serina	1.465	2.037	2.445	2.249	2.159	0.620	0.852
Glycine	1.993	2.594	2.574	2.874	2.044	0.671	1.368
Threonine	0.850	1.261	1.849	1.298	1.564	0.419	0.607
Arginine	1.803	3.040	4.318	4.645	4.289	1.096	1.194
Alanine	1.145	2.302	2.080	1.671	1.736	0.476	0.735
Tyrosine	0.400	0.674	1.047	1.459	0.914	0.189	0.280
Valine	1.341	1.975	1.970	1.590	1.619	0.444	0.704
Phenylalanine	1.350	1.691	2.120	1.741	1.661	0.454	0.604
Isoleucine	0.987	1.209	1.681	1.265	1.370	0.401	0.569
Leucine	1.659	2.392	2.517	2.459	2.567	0.737	1.016
Lysine	1.043	2.099	1.497	1.726	1.136	0.242	0.473
Cystine	0.338	0.437	0.649	0.415	0.507	0.204	0.307
Methionine	0.375	0.443	0.509	0.469	0.469	0.142	0.181

Table 3 data show that the flaxseed meal and the walnut meal have the highest levels of linolenic acid, with 68.57% and 8.47%, for the flaxseed meal and walnut meal, respectively, as also shown by Ω6/Ω3 ratio, which was 0.15 (flaxseed meal) and 7.81 (walnut meal).

The fatty acids profile (Table 3) showed that the flaxseed meal is particularly rich in omega 3 polyunsaturated fatty acids (omega 3 PUFA), as also shown by other authors [30, 2]. The data for walnut meal are comparable with those of [21].

Due to the fact that some of these by-products are high-fat raw materials, we determined the fat degradation indices. The results obtained for the 7 by-products (Table 4) indicate that the fat degradation indices were within the maximum admissible limits for compound feed (STAS 12266-84) for storage periods, 14 days and 28 days (Table 4). For the peroxide index, the maximum admissible limit is 1.2 ml thiosulphate 0.01 N/g fat, and for fatty acid the maximum admissible value is 50 mg KOH/g fat.

Table 3. Fatty acids profile in the studied plant by-products

Item		Sunflower meal	Wheat germ meal	Flaxseed meal	Grapeseed meal	Pumpkin meal	Walnut meal	Rosehip meal
		g/100g total fatty acids						
Caprylic	C8:0	-	-	-	-	0.14	0.06	0.58
Capric	C 10:0	-	-	-	-	0.07	0.04	0.21
Myristic	C 14:0	0.06	0.06	0.03	0.07	0.16	0.09	0.39
Pentadecanoic	C 15:0	0.00	0.00	0.00	0.11	0.00	0.00	0.64
Pentadecenoic	C 15:1	-	-	-	-	0.00	0.00	0.52
Palmitic	C 16:0	3.89	8.79	3.95	5.29	8.15	4.63	7.47
Palmitoleic	C 16:1	0.11	0.00	0.04	0.08	0.04	0.00	0.00
Stearic	C 18:0	1.49	0.64	1.27	2.13	1.76	1.26	3.04
Oleic cis	C 18:1	56.72	20.77	15.88	11.26	37.30	19.28	32.12
Linoleic cis	C 18:2n6	37.71	67.53	10.22	80.62	52.14	66.18	50.26
Linolenic α	C 18:3n3	0.03	1.99	68.57	0.22	0.14	8.47	4.69
Eicosadienoic	C 20:2n6	0.00	0.22	0.00	0.00	-	-	-
Arachidonic	C20(4n6)	0.00	0.00	0.00	0.22	0.10	0.00	0.00
Fatty acids profile								
ΣSFA		5.44	9.49	5.28	7.60	10.27	6.07	12.41
ΣMUFA		56.82	20.77	15.92	11.34	37.34	19.28	32.65
ΣUFA		94.56	90.51	94.72	92.40	89.73	93.93	87.59
ΣPUFA. Of which:		37.74	69.74	78.80	81.06	52.38	74.65	54.94
ΣΩ3		0.03	1.99	68.57	0.22	0.14	8.47	4.69
ΣΩ6		37.71	67.75	10.22	80.84	52.24	66.18	50.26
Ω6/Ω3		1137.37	34.00	0.15	372.10	366.15	7.81	10.73

*Where: SFA=saturated fatty acids; MUFA=monounsaturated fatty acids; UFA=unsaturated fatty acids; PUFA=polyunsaturated fatty acids;

Table 4. Fat degradation indices in the analysed by-products (average values/group)

Shelf time		Sunflower meal	Wheat germ meal	Flaxseed meal	Pumpkin meal	Walnut meal	Rosehip meal	Grapeseed meal
Peroxide value (ml thiosulphate 0.01N/g fat)	initial	0.369	0.396	0.319	0.332	0.371	0.308	0.316
	14 days	0.461	0.423	0.435	0.443	0.433	0.451	0.423
	28 days	0.504	0.507	0.515	0.515	0.521	0.524	0.533
Fat acidity (mg KOH/g fat)	initial	12.41	12.22	12.98	12.42	12.49	12.64	12.89
	14 days	15.46	15.65	15.95	15.21	15.97	15.28	15.69
	28 days	17.98	17.8	17.2	17.39	17.72	17.45	17.78
Kreiss reaction	initial	negative	negative	negative	negative	negative	negative	negative
	14 days	negative	negative	negative	negative	negative	negative	negative
	28days	negative	negative	negative	negative	negative	negative	negative

Table 5 presents the results of digestibility of organic substance (dSO) and digestible energy (ED) of studied vegetable by-products. The results presented in Table 5, in terms of digestible energy values, show differences in relation to higher values in the case of flaxseed meal (18.06 MJ) and lower in grape seed meal (8.05 MJ). This difference is also found in the content of digestible organic substance (SOD). The literature offers varied results in terms of digestible energy.

Table 5. Organic matter digestibility and digestible energy (values/1000 g DM)

Specification	SO g/kg DM	dSO %	SOD g	DE MJ
Sunflower meal	948.33	62.63	593.94	14.04
Wheat germs meal	949.30	79.31	752.89	16.71
Flaxseed meal	950.30	82.38	782.86	18.16
Pumpkin meal	942.73	66.15	623.62	15.23
Walnut meal	944.07	71.41	674.16	16.60
Rosehip meal	975.56	45.2	440.95	8.23
Grapeseed meal	968.43	44.36	429.60	8.05

*Where: SO=organic matter; dSO=organic matter digestibility; SOD=digestible organic matter; DE=digestible energy

The content of intestinally digestible protein allowed by the nitrogen content (PDIN) of the raw materials (Table 6) varies between 920 g/kg DM (pumpkin meal) and 871 g/kg DM (wheat germ meal), which means about 37% of the raw materials dry matter. Table 6 data show that both PDIN and PDIE fail to preserve the same ratios. The highest values for PDIE, were noticed in the flaxseed meal (118 g PDIE/kg DM). The walnut meal had 85 g PDIE/kg DM, which is very close to the pumpkin meal, 81g PDIE/kg DM. The rosehip meal had the lowest amounts of intestinally digestible protein allowed by the energy content (63 g PDIE/kg DM). A main remark and clearly observed by [34] feeding crops and agro-industrial by-products, will therefore have to take into consideration not only the above described characteristics but also the kinetics of release of the various nutrients. The feeding value expressed as FU_{milk} and FU_{meat}, had values correlated with the protein content of the feeds: 0.57 FU_{milk}/kg DM and 0.44 FU_{meat}/kg DM (grape seed meal) and 1.45 FU_{milk}/kg DM and 1.48 FU_{meat}/kg DM (flaxseed meal).

Table 6. Feeding value, energy and protein content of the analysed by-products (values/1000 g DM)

Specification	SU (g)	FU_{milk}	FU_{meat}	PDIN (g)	PDIE (g)
Sunflower meal	909.15	1.06	0.99	157	73
Wheat germs meal	877.11	1.33	1.34	202	76
Flaxseed meal	907.16	1.45	1.48	247	118
Pumpkin meal	920.00	1.11	1.04	232	81
Walnut meal	907.87	1.29	1.28	212	85
Rosehip meal	904.65	0.58	0.46	72	63
Grapeseed meal	894.52	0.57	0.44	94	70

*Where: SU=dry matter; FU_{milk}=milk feed units; FU_{meat}=meat feed units; PDIN=intestinally digestible protein allowed by the nitrogen content; PDIE=intestinally digestible protein allowed by the energy content;

4. Conclusions

- The basic chemical analysis of the plant by-products documented a high protein level of 6 of the 7 by-products, with a variable profile of the amino acids.
- The flaxseed, walnut and rosehip meals had a high content of polyunsaturated fatty acids, linolenic acid particularly, which prompts the use of these meals in dairy cows feeding with the purpose of enhancing the polyunsaturated fatty acids content of the milk, being major sources of raw materials for this purpose.
- By using this plant by-products from the residue from processing the oils in the ratios of ruminants during lactation could increase the milk production and the quality of the milk.

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References

1. Moran, J., Tropical dairy farming: feeding management for small holder dairy farmers in the humid tropics. Chapter 6. Landlinks Press. 2005, pp 51-59. 71.
2. Panaite, T. D., Criste, R. D., Ropota, M., Criste, V., Vasile, G., Olteanu, M., Vlaicu, A., Determination of the feeding value of food industry by-products, Lucrări Științifice-Universitatea de Științe Agricole și Medicină Veterinară, Seria Zootehnie, 2016, 66, 106-111.
3. Eastridge, M. L., Major advances in applied dairy cattle nutrition, Journal of dairy science, 2006, 89(4), 1311-1323.
4. Jabbar, M. A., Sunflower meal, an economical substitute of cotton seed cake in livestock feeding. In: Project Report. Livestock Production Research Institute Bahadarnagar, Okara, 1998, 25-26.
5. Ge, Y.; Sun, A., Ni, Y., Cai, T., Study and development of a defatted wheat germ nutritive noodle, European Food Research and Technology, 2001, 212 (3), 344–348.
6. Chow, C. K., Fatty Acids in Food and Their Health Implications. Marcel Dekker, New York, NY., 1992.
7. De Vries, A., Economic value of pregnancy in dairy cattle. J. Dairy Sci., 2006, 89, 3876–3885.
8. AACC Report. The definition of dietary fiber. Cereal Foods World, 2001, 46, 3.
9. Nakamura, Y., Watanabe, S., Miyake, N., Kohno, H., Osawa T., Dihydrochalcones: evaluation as novel radical scavenging antioxidants, Journal Agriculture Food Chemistry, 2003, 51, 3309-3312.
10. Bombardelli, E., Morazzoni, P., *Vitis vinifera* L. Fitoterapia, 1995, 16, 291-317.
11. Sauro-Calixto F., Antioxidant dietary fi ber product: A new concept and a potential food ingredient. J. Agr. Food Chem., 1998, 46, 4303-4306.
12. Saito, M., Hosoyama, H., Ariga, T., Kataoka, S., Yamaji, N., Antiulcer activity of grape seeds extract and procyanidins, J. Agr. Food Chem., 1998, 46, 1460-1464.
13. Burlacu, G. H., Cavache, A., Burlacu, R., Productive potential and use of forages, Ed. Ceres, 2002.
14. Tilley, J. M. A., Terry, R. A., , A two-stage technique for the in vitro digestion of forage crops, J. Brit. Grassl. Soc., 1963, 18, 104-111.
15. Verite R., Geay Y., Testing and implementing the PDI system in France. In: Jarrige R., Alderman G. (ed.), Feed evaluation and protein requirements systems for ruminants. Proc. Of a CEC Seminar, 25-27 June 1986, Brussels, 249-261, CEC. L-2985, Luxembourg, 1987.
16. Vlaicu, P. A., Panaite, T. D., Dragotoiu, D., Ropota, M., Bobe, E., Olteanu, M., Criste, R. D., Feeding quality of the meat from broilers fed with dietary food industry by-products (flaxseed, rapeseeds and buckthorn meal, grape pomace), Scientific Papers: Series D, Animal Science-The International Session of Scientific Communications of the Faculty of Animal Science, 2017, 60.
17. Criste, R. D., Panaite, T. D., Tabuc, C., Sărăcilă, M., Șoica, C., Olteanu, M., Effect of oregano and rosehip supplements on broiler (14-35 days) performance, carcass and internal organs development and gut health, AgroLife Scientific Journal, 2017, 6(1), 2286-0126.
18. Vlaicu, P. A., Dragotoiu, D., Panaite, T. D., Untea, A., Saracila, M., Mitoiu, M., Effect of rosehip addition to pufa Ω3-high layer diets on hen performance and egg quality. In Proceedings of the 21st European Symposium on Poultry Nutrition ESPN 2017,http://www.wageningenacademic.com/doi/abs/10.3920/978-90-8686-851-3
19. Brunschwig, P., Le tourteau de noix, Institut de l'Elevage, 2 décembre, 2003.
20. McGregor, C. A., Directory of Feeds and Feed Ingredients, Third Edition, Hoards Diaryman, U.S.A 70, 2000.
21. Panaite T. D., Criste R. D., Ropota M., Olteanu M., Mitoi M., Varzaru I., Untea A., Effect of using nuts meal in diet formulations on layer performance and egg quality, Lucrări Științifice-Universitatea de Științe Agricole și Medicină Veterinară, Seria Zootehnie, 2017, 67(22) 156-160.
22. Alcaide, E. M., Ruiz, D. Y., Moumen, A., Garcıa, A. M. (). Ruminal degradability and in vitro intestinal digestibility of sunflower meal and in vitro digestibility of olive by-products supplemented with urea or sunflower meal: comparison between goats and sheep, Animal Feed Science and Technology, 2003, 110(1-4), 3-15.
23. Noor Aziah A. A, Komathi C. A, Bhat R., Evaluation of Resistant Starch in Creckers Incorporated with Unpeeld and Peeled Pumpkin Flour, Am J Food Technol., 2011, 6(12), 1054-1060.
24. Lardy, G. P., Anderson, V., Canola and sunflower meal in beef cattle diets. Veterinary Clinical orth American Food Animal Practice, 2002, 18, 327-328.
25. Oeffner, S. P., Qu, Y., Just, J., Quezada, N., Ramsing, E., Keller, M., Cherian, G., Goddick, L. et al., Effect of flaxseed supplementation rate and processing on the production, fatty acid profile, and texture of milk, butter, and cheese. J Dairy Sci., 2013, 96, 1177–1188.
26. Moats, J., Mutsvangwa, T., Christensen, D.,. Effects of extruded flaxseed and condensed tannins on rumen fermentation, omasal flow of nutrients, milk composition and milk fatty acid profile in dairy cattle. Master's Thesis, University of Saskatchewan, 2015, https://ecommons.usask.ca/bitstream/handle/10388/ETD-2016-01- 2410/MOATS THESIS.pdf?sequence=5.
27. Vasta, V., Mele, M., Serra, A., Scerra, M., Luciano, G., Lanza, M. and Priolo, A., Metabolic fate of fatty

acids involved in ruminal biohydrogenation in sheep fed concentrate or herbage with or without tannins, J Anim Sci., 2017, 87, 2674–2684.
28. Enjalbert, F., Combes, S., Zened, A. and Meynadier, A., Rumen microbiota and dietary fat: a mutual shaping, J Appl Microbiol., 2017, 123, 782–797 https://doi.org/10.1111/jam. 13501.
29. Vasta, V., Y_a~nez-Ruiz, D.R., Mele, M., Serra, A., Luciano, G., Lanza, M., Biondi, L. and Priolo, A., Bacterial and protozoal communities and fatty acid profile in the rumen of sheep fed a diet containing added tannins, Appl Environ Microbiol., 2010, 76, 2549–2555.
30. Aziza A. E., Panda A. K, Quezada N., Cherian G., Nutrient digestibility, egg quality, and fatty acid composition of brown laying hens fed camelina or flaxseed meal-Department of Animal and Rangeland Sciences, Oregon State University, Corvallis 97331, 2013.
31. El-Shami, S. M., El-Mallah, M. H., Mohamed, S. S., Studies on the lipid constituents of grape seeds recovered from pomace resulting from white grape processing, Fats and Oils Dept., National Research Centre, Dokki, Cairo, Egypt, 1992, 43(3).
32. Olteanu, M., Criste, R.D., Panaite, T. D., Ropota, M., Mitoi, M., Varzaru, I., Untea, A. E., Study of the feeding value and antioxidant capacity of winery by-products, potential natural antioxidants for farm animal diet formulations, Archiva Zootechnica, 2014, 17(2), 55-71.
33. Martíne Y., Valdivi M., Martíne O., Estarró M., Córdov J., Utilization of pumpkin (*Cucurbita moschata*) seed in broiler chicken diets, Cuban Journal of Agricultural Science, 2010, 44(4).
34. Preston, T. R., Leng, R. A., Sugarcane as cattle feed. Part 1: Nutritional constraints and perspectives. World Animal Review 27: 7–12; Part II: Commercial application and economics. World Animal Review 1978, 28, 44–48.