Romanian Biotechnological Letters *Vol. 18, No. 5, 2013*
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ORIGINAL PAPER

The seed's and oil composition of Camelia – first romanian cultivar of camelina *(Camelina sativa,* L. Crantz)

Received for publication, August 30, 2013
Accepted, September 30, 2013

ION TONCEA[1], DAN NECSERIU[2], TUDOR PRISECARU[3], LILIANA-NADIA BALINT[4], MADALINA-IRINA GHILVACS[5], MIHAELA POPA[6]
1.Research, Innovation and Technical Assistance Center for Organic Farming, National Agricultural Research and Development Institute, Fundulea 915200, Calarasi County, Romania.
2. Suisse trail srl, Bogdan Voda str. 10, 500449 Brasov/Romania;
3. Bucharest Polytechnic University, Splaiul independentei str., nr. 313, sector 6, Bucharest; E-mail: tudor_prisecaru@mail.com;
4. ICA Research&Development srl, Bucharest/Romania, E-mail: l.balint@ccai-ro.com;
5. INMA Bucharest, E-mail: make_madalina@yahoo.com;
6. Procera Agrochemicals Romania s.r.l, Muncii str., nr. 47, 915200 Fundulea, Calarasi County, Romania, E-mail: ionita_mihaela@yahoo.com;
Ion Toncea, Phone: 00 40 21 315 40 40, Fax: 00 40 21 311 07 22; E-mail: toncea@ricic.ro

Summary

Variability in camelina (Camelina sativa, L. Crantz) seeds and oil composition could be expected between cropping year, sowing time, cultivar and genetic x environment's interactions, as well farming systems. The objectives of the present study were to determine the seeds and oil composition variability due by organic and low input farming systems, cropping year, sowing time and cultivar, as well as, organic seeds, fats and meal (cake) elemental composition and calorific power values of Camelia, first Romanian camelina (Camelina sativa, L. Crantz) cultivar. Between 2004 – 2013 different field experiments with camelina were carried out at NARDI Fundulea, including five years (2009-2013) yield trial in organic farming, and a three year (2008-2010) yield trial in low input farming established that camelina Camelia seeds contain, mainly, 4,25 – 5,24% ash, 11,06 – 15,24% cellulose, 18,87-21,97% proteins, 30,1 – 49,7% fats, and 25,83 – 28,21 mg/100 g vitamin E, as well as minerals – 0,18% Calcium (Ca), 0,53 % Phosphorus (P), 0,49% Cooper (Cu), 1,39 % Manganese (Mn), 4,47 % Iron (Fe) and 2,56 % Zinc (Zn). In organic yield trial, the best years for Camelia fats(oil) content were 2009 (43,9%) and 2012 (44,2%) and the bad year was 2010 (31,4%). Also, the sowing time effect on fats(oil) content ranged between 29,3 – 46,3% in late autumn and 33,4 – 49,6% in early spring. There appears to be some variation for fats(oil) content among the years and cultivars tested: 31.1 – 45,8% at Camelia, 31,9 – 44,8% at Calena and 30,7 – 43,6% at Lindo. In low input farming system, the fats(oil) content of cultivars studied ranged between 32,7 – 35,9% at Camelia and 29,5 – 33,8% at Lindo. The organic seeds and cold oil of Camelia contained two essential fatty acid types: ω-3 (31,9 – 53,4%) and ω-6 (18,6 – 21,61%), as well nonessential ω-9 (17,4 – 36,6%). The fatty acids in Camelia seeds and cold oil are principally unsaturated (85,3– 89,4%), with only 9,1 – 11,2% being saturated. More than 55% of the fatty acids are polyunsaturated, primarily linoleic (18:2) and α-linolenic (18:3), and 32% are monounsaturated, primarily oleic (18:1), eicosenoic/gadoleic (20:1), and erucic acid (22:1). Camelia α-linolenic fatty acid was higher in late autumn sowing time seeds and oil samples when was compared to that of Camelia seeds and cold oil spring sowing time samples. The average ω-6 to ω-3 ratio in Camelia seeds and cold oil was 1: 1,5 – 2,87 and inverse to the ideal ratio: 3 – 3:1 to 5:1. The Camelia cold oil was susceptible to auto oxidation, thus giving it a shorter shelf life. Also, the fatty acids composition of Camelia seeds and cold oil was not significant different. The calorific power values of the Camelia main commercial products, classified the Camelia seeds besides Anthracite coal, the Camelia meal(cake) besides Bituminous coal, and Camelia cold oil besides Jatropha based biodiesel and fuel oil.

Key words: *Camelina sativa L. crantz*, cold fats(oil), fatty acids, composition, calorific power value

Introduction

Camelia is the name of the first Romanian camelina (*Camelina sativa L. crantz)* variety. It was registered in 2011 (SIVTR,2012) as a line of Calena, an Austrian camelina variety.
In recent years, camelina production has increased somewhat due heightened interest in vegetable oils high in omega-3 fatty acids, a principle component of camelina oil (Ehrensing and Guy, 2008).
The use Camelia seeds, oil and meal in regeneration rubber composition (David et al., 2011) and approval of commercial camelina fuel uses (Tannith Cattermole, 2011), are other factors of increasing the interest in *Camelina sativa*, including in Romania.
Variability in camelina (Camelina sativa, L. Crantz) seeds and oil composition could be expected between cropping year, sowing time, cultivar and genetic x environment's interactions, as well farming systems. The objectives of the present study were to determine the seeds and oil composition variability due by organic and low input farming systems, cropping year, sowing time and cultivar, as well as, organic seeds, fats and meal (cake) elemental composition and calorific power values of Camelia, first Romanian camelina (Camelina sativa, L. Crantz) cultivar.

Material and methods

Between 2004 – 2013 different field experiments with camelina were carried out at NARDI Fundulea, in the experimental field of the Research, Innovation and Technical Assistance Center for Organic Agriculture (loam textured soil), including a field trial in the last 5 years (2009 – 2013) with 3 camelina cultivars bred in Fundulea/Romania (Camelia), Austria (Calena) and Germany (Lindo).

Camelia and Lindo cultivars were tested in low input farming system too. It was carried on 3 years (2008-2010) in the fields of 4 testing centers (Dej, Dilga, Mircea Voda and Sibiu) of the State Institute for Variety Testing and Registration (SIVTR) which belongs to 3 ecosystems (Table 1).

Table 1. SIVTR locations where camelina cultivars was grown

Locations	Ecosystem	Air temperature	Rainfall	Elevation (m)	Latitude	Soil type
		Mean/year				
		(^{0}C)	mm			
Mircea Voda	Romanian Plain	11,0	447	37	45^{0}12'N	Cambic and vermi-mould
Dîlga		11,0	555	51	44^{0}25'N	Wet, Gleyed chernozem
Fundulea		10.5	571	68	44^{0}30'N	Chernozem
Dej	Contact area of Transylvania Plain with Somesan Plateau	8,7	598	235	47^{0}09'N	Sandy loam Clay loam
Sibiu	Sibiu depression	8,7	636	400	45^{0}61'N	Cambic mould

The inputs in all SIVTR centers, consisted in annual nitrogen and phosphate applied at 40-60 kgN/ha and 30 – 60 kg P_2O_5/ha rate. Also, herbicides, fungicides or insecticides were no used.

At harvest were taken one seed sample from organic and conventional plots, to determine grains moisture and fats (oil) contents, as well as fatty acids composition. Another seed sample was used for cold oil extraction and meal producing, to determine their fatty acids and elemental composition and calorific values.

Laboratory analysis

The mineral concentration of seeds was determined by different methods: Phosphorus (P) colorimetric, and Calcium (Ca) and micronutrients (Cu, Mn, Fe and Zn) by Atomic Absorption Spectrophotometry (AAS) method.

Organic camelina seeds composition in water and fats was analyzed with INSTALAB 660, a *Dickey-John* infrared analytical tester for grain analysis, and low inputs camelina seeds with nuclear magnetic resonance (NMR) equipment, AREMI 101,

Fatty acids composition of Camelia seeds and cold pressing oil was examined by Gas Chromatography with Flame Ionization Detector (GC-FID) method.

Elemental composition (C,H,N,S,O) and inferior calorific power (Qi) of Camelia seeds, cold oil and meal (cake) was examined with elemental analyzer COSTECH ECS 4010, and according to technical standards 5264/1986 for water and 5256/1986 for ash content. Also, the values of inferior calorific power (Qi) of Camelia seeds, cold oil and meal (cake) were estimated with Mendeleev formula quoted by Pîşă, I., 2008: $Qi=339Ci + 1030Hi + 109(Si-Oi) – 25,1Wi,$ where , C_i is carbon content; H_i – hydrogen content; S_i – sulfur content; O_i – oxygen content and W_i - water content. The values of calorific power are expressed in energy units, kilojoules (kj) or mega joules (Mj) per kilogram (kg).

Statistical analysis

A three-way analysis of variance (ANOVA) was performed in case of fats (oil) content. Also, the dispersion in time of different parameters was estimated by coefficient of variation (CV).

Results and discussion

Three main characteristics of camelina were estimated: seeds content in organic and mineral substances, with focus on fats (oil) content, fatty acids composition of seeds and cold oil and elemental composition and calorific power values of seeds, cold oil and meal.

Camelia seeds composition

Camelia seeds contain (Table 2), mainly, 4,25 – 5,24% ash, 11,06 – 15,24% cellulose, 18,87-21,97% proteins, 30,1 – 49,7% fats, and 25,83 – 28,21 mg/100 g vitamin E (gama tocopherol), as well as minerals – 0,18% Calcium (Ca), 0,53 % Phosphorus (P), 0,49% Cooper (Cu), 1,39 % Manganese (Mn), 4,47 % Iron (Fe) and 2,56 % Zinc (Zn).

The Camelia seed appears to be similar to sunflower (Helianthus annus) in ash content, to safflower (Carthamus tinctorius) in fats content, to linseed (Linum ussitatisimum) in protein content, and to almonds (Amigdalus comunis) in vitamin E content.

Table 2. Camelia seeds composition (Fundulea, 2004 – 2013)

Components	U.M.	Values	CV (%)	Components	U.M.	Values
Ash	%	4.25 – 5.24	11.31	Ca	%	0.18
Cellulose	%	11.06 – 15.24	14.35	P	%	0.53
Proteins	%	18.87 – 21.97	6.26	Cu	%	0.49
Fats (oil)	%	30.10 – 49.7	15.10	Mn	%	1.39
Vitamin A	mg/100g	abs.		Fe	%	4.47
Vitamin E	mg/100g	25.83 – 28.21	4.52	Zn	%	2.56
Vitamin B1	mg/100g	0.20				
Vitamin B2	mg/100g	0.55				

Camelia seeds oil content placed it in the group of oilseeds and in the top 5 richness in vitamin E crops. The vitamin E of Camelia seeds is considered to be safe and healthy, acts as an antioxidant increasing the stability and shelf life of camelina oil (Ehrensing and Guy, 2008) and, maybe, confers the camelina renown of "Gold of pleasure" in England and "Lubit(a)" in Romania and Russia. Also, Camellia seeds are a good source of proteins, fiber, and minerals, especially Iron (Fe), Zinc (Zn) and Manganese (Mn).

Coefficient of variation (CV) in time of Camelia seeds composition was, according to Ceapoiu (1968), low in the case of vitamin E (4,52%) and proteins (6,26%), and moderate in the case of ash (11,31%), cellulose (14,35%) and fats (15,10%) content.

The highest CV of fats(oil) content is confirmed by ANOVA Table 3, especially as result of the cropping year (Y), sowing time (St), cultivar (V) and their interactions significant effect on fats content.

The cropping year (Y) had the largest effect on organic Camelia seed fats. The results of sowing time (St), and it's interaction with year – YxSt was second very significantly (P>0.01) different. The third very significantly (P>0.01) different were interactions of cultivar with year (YxV) and sowing time (StxV), but cultivar effect and it's year (Y) x sowing time (St) x cultivar (V) interaction were just significant (P>0.05) and low different.

Table 3. Three-way analyses of variance (ANOVA) of fats (oil) content of camelina seeds in different years, sowing time and cultivars (Fundulea, 2009 – 2012)

Source of variation	The sum of squares (SS)	Degree of freedom (df)	Mean square (MS)	F-value	F-table 0.05	F-table 0.01
Replication	2	2				
Year (Y)	2586.51	4	646.63	159.78	3.84	7.01
Error (Y)	32.38	8	4.05			
Sowing time (St)	108.90	1	108.90	20.43	4.96	10.04
Interaction (YxSt)	671.21	4	167.80	31.48	3.48	5.99
Error (St & YxSt)	53.31	10	5.33			
Cultivar (V)	19.16	2	9.58	3.49	3.23	5.18
Interaction (YxV)	232.00	8	29.00	10.55	2.18	2.99
Interaction (StxV)	42.84	2	21.42	7.80	3.23	5.18
Interaction (YxStxV)	53.08	8	6.63	2.41	2.18	2.99
Errors (V, YxV, StxV and YxStxV)	109.93	40	2.75			
Total	3911.32	89				

The oil content of Camelia seeds has ranged from 29,3 to 49,6% in our studies (fig.1). Studies in Rosemount, Minnesota (Putnam 1993) and Germany (Marquard and Kuhlmann 1986, reported by Putnam et al. 1993) have shown camelina oil content to range between 29 and 39%, respectively between 37 and 41%.

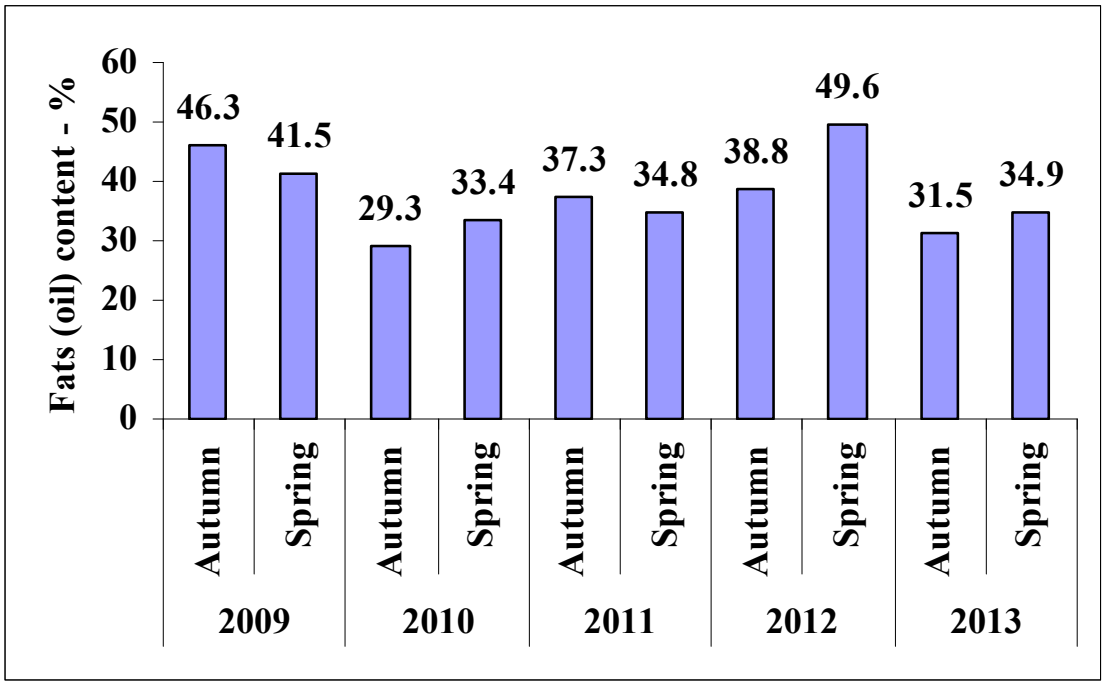

Figure 1. The environment effects on fats (oil) content of Camelia seeds in organic farming *(Fundulea, 2009 – 2013)*

In our organic field trial studies, the best years for Camelia fats(oil) content were 2009 (43,9%) and 2012 (44,2%) and the bad year was 2010 (31,4%). Also, the sowing time effect on fats(oil) content ranged between 29,3 – 46,3% in late autumn and 33,4 – 49,6% in early spring.

There appears to be some variation for fats(oil) content among the years and cultivars tested (Fig.2): 31.1 – 45,8% at Camelia, 31,9 – 44,8% at Calena and 30,7 – 43,6% at Lindo.

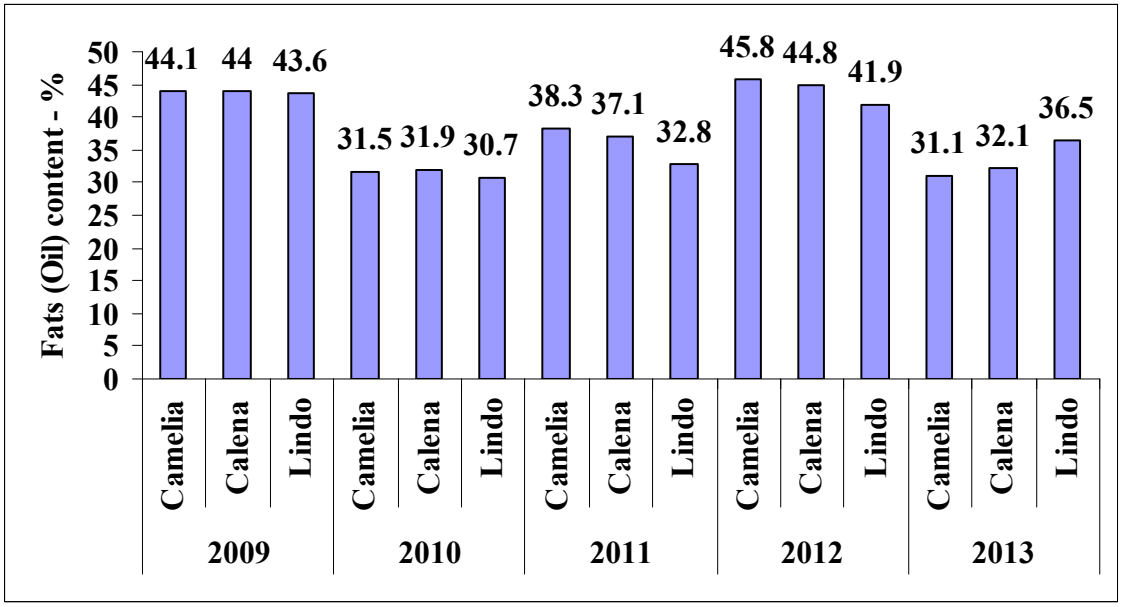

Figure 2. Seed fats (oil) content of camelina cultivars in organic farming (Fundulea, 2009 – 2013)

The Camelia top position in fats (oil) content was reported by the SIVTR studies too (table 4). The fats(oil) content of cultivars studied in low input farming ranged between 32.7 – 35.9% at Camelia and 29.5 – 33.8% at Lindo. Also, the fats(oil) yield in SIVTR tested centers ranged between 652 – 803 kg/ha at Camelia and 631 – 735 kg/ha at Lindo.

Table 4. The seed fats(oil) content and yields of camelina cultivars in low input farming (SIVTR, 2008-2010)

Altitude (m)	Fats(oil) content (%)		Fats(oil) yield (kg/ha)	
	Camelia	Lindo	Camelia	Lindo
37	32.7	30.9	652	631
51	33.0	30.0	762	720
235	35.9	33.8	803	735
400	34.2	29.5	788	726
Average	33.8	31.4	751	703

Fatty acids composition of Camelia seeds and cold oil

Gas chromatography analysis showed the presence in Camelia seeds and cold oil of palmitic (C16), stearic (C18), oleic (C18:1), linoleic (C18:2), α-linolenic (C18:3), arachic (C20), eicosenoic/gadoleic (C20:1), eicosadienoic (C20:2), eicosatrienoic (C20:3) and erucic (C22:1) fatty acids (Table 5). Camelia seeds and cold oil contain traces (< 1%) of miristic (14:0), behenic (22:0), nervonic (24:1) and other omitted fatty acids too.

Camelia seeds and oil are very rich in α-linolenic (30,5 – 50,3%), and relatively rich in linoleic (16,60 – 19,82%), and oleic (14,90 – 16,50%) fatty acids. The ratio of α-linolenic to linoleic fatty acids is 1,57 – 3,03 to 1. However, the highest level of this ratio was due only in cold oil extracted from seeds of crops seeding in Brasov in autumn 2009, because the α-linolenic increased till 50,3%, erucic acid (22:1) decreased till 1,60%, lower than the maximum (2%) allowed in canola oil (Ehrensing and Guy, 2008), and eicosenoic/gadoleic acid was in traces. Except this unusual case of trace content of eicosenoic/gadoleic fatty acid of Brasov oil extracted from Camelia seeds seeding in autumn 2009, in the other tested year (2007, 2009 and 2012), the Camelia seeds and cold oil had the highest eicosenoic/gadoleic fatty acid content (14,8 – 17,5%), comparative to 11,99% camelina oil content reported by Putnam et. al (1993).

Also, the Camelia fatty acids had, according to Ceapoiu (1968), a low variation (CV) in time) of oleic (3,60%), linoleic (6,08%), stearic (8,54), arachic (8,33%) and palmitic (10,73%) fatty acids, and a high variation of α-linolenic (21,57%), erucic (27,60%) and behenic (28,29%) fatty acids. The highest coefficient of variation (>30%) was registered in case of eicosenoic/gadoleic (49,62%), and trace or sometimes omitted fatty acids.

The seeds and cold oil of Camelia contain two essential fatty acid types: Omega(ω)-3 (31,9 – 53,4%) and Omega(ω)-6 (18,2 – 21,61%), as well nonessential Omega(ω)-9 (17,4 – 36,6%). The average ω-6: ω-3 ratio is about 1: 1,5 – 2,87 and it is complete different to the ideal ratio: 3 – 3:1 to 5:1 reported by Simopoulus A.P. and Cleland LG, 2003. The ω-6: ω-3 ratio was lower (0,35) and similar to Chia (Salvia hispanica L.) results reported by Ayerza Ricardo, 2009, only in high α-linolenic oil of Camelia 2010, cultivated in autumn 2009 in Brasov area. Also, the fatty acids composition of seeds and cold oil of Camelia seems to be not significant different.

Table 5. The fatty acids composition of organic seeds and cold pressing oil of Camelia cultivated in different areas and years ***(Fundulea, 2007 and 2012 & Braşov, 2009, 2010)***

Fatty acid	Fatty acids of seeds (Fundulea - %)			Fatty acids of cold oil (Braşov - %)			C.V. (%)
	2007[x]		2012[xxx]	2009[xx]	2009 analyzed in 2012[xxx]	2010[xx]	
	Spring crop	Autumn crop	Autumn crop	Spring crop		Autumn crop	
Palmitic (C16:0)	6,59	6,13	5,23	5,30	5,32	5,10	10,73
Stearic (C18:0)	2,40	2,24	2,19	2,50	2,70	2,20	8,54
ω-9 Oleic (C18:1)	15,39	15,65	16,50	15,50	15,1	14,90	3,60
ω-6 Linoleic (C18:2)	19,82	18,50	18,49	17,90	19,27	16,60	6,08
ω-3 α-linolenic (C18:3)	31,19	33,52	33,35	30,5	31,50	50,30	21,57
Arachic (C20:0)	1,78	1,61	1,38	1,60	1,70	1,60	8,33
ω-9 Eicosenoic (C20:1)	14,79	14,8	15,11	17,5	15,24	0,00	49,62
ω-6 Eicosadienoic (C20:2)	1,79	1,81	-	0,30	-	2,00	53,49
ω-3 Eicosatrienoic (C20:3)	1,14	1,30	-	1,40	-	3,10	52,90
Behenic (C22:0)	0,39	0,34	0,38	0,20	0,36	0,20	28,29
ω-9 Erucic (C22:1)	3,59	3,35	3,10	3,10	4,23	1,60	27,60
ω-9 Nervonic (C24:1)	0,62	0,42	0,60	0,50	0.00	0,90	58,58

The fatty acids of Camelia seeds and cold oil are principally unsaturated (85,3– 89,4%), with only 9,1 – 11,2% being saturated (Table 6). More than 55% of the fatty acids are polyunsaturated *(fatty acids that contain more than one double bond in the fatty acid chain)*, primarily linoleic (18:2) and α-linolenic (18:3), and 32% are monounsaturated *(fatty acids that have one double bond in the fatty acid chain)*, primarily oleic (18:1), eicosenoic/gadoleic (20:1), and erucic acid (22:1). With its low saturated fat content camelina oil could be considered high quality edible oil, but it is also quite highly polyunsaturated, that makes it susceptible to autoxidation, thus giving it a shorter shelf life (Putnam, 1993). It was ascertained by us too in a Camelia oil sample stored in a transparent glass bottle since 2007, and high α-linolenic oil of 2010 autumn crop which in 2013 could not be esterified and fatty acid composition could not be investigated.

Table 6 Saturated and unsaturated fatty acids composition of Camelia seeds and cold oil

Fatty acids types	Camelia seeds (Fundulea, 2007 - %)			Camelia cold oil (Braşov, 2009 & 2010 - %)		
	2007[x]		2012[xxx]	2009[xx]	2009 analyzed in 2012[xxx]	2010[xx]
	Spring crop	Autumn crop	Autumn crop	Spring crop		Autumn crop
Saturated fatty acids	11,16	10,32	9,18	9,60	10,08	9,1
Monounsaturated acids	34,39	34,22	35,31	36,6	34,57	17,4
Polyunsaturated acids	53,94	55,13	51,84	50,1	50,77	72,0
Omega-3 fatty acids	32,33	34,82	33,35	31,9	31,5	53,4
Omega-6 fatty acids	21,61	20,31	18,49	19,26	18,60	19,0
Omega-9 fatty acids	34,39	34,22	35,31	36,6	34,57	17.4

x – National Research-Development Institute for Animal Biology and Nutrition. Balotesti. Romania xx – Swiss Quality Testing Services (SQTS);
xxx – Procera Agrochemicals Romania srl;

Elemental composition and inferior calorific power

Elemental COSTECH ECS 4010 analysis showed the presence in Camelia seeds of carbon (58,9%), oxygen (20,045%), Hydrogen (8,6%), nitrogen (3,7%), water (4,262%), ash (4,193%) and sulfur (0,3%). The Camelia cold oil contain: 75,5% carbon, 12,6% oxygen, 11,6% hydrogen and 0.3% sulfur. Also, the Camelia seeds meal (cake) contain: carbon (51%), oxygen (23,117%), hydrogen (7,4%), nitrogen (4,7%), water (6,797%), ash (6,686%) and sulfur (0,3%).

Table 7. Elemental composition and inferior calorific power of Camelia organic seeds harvested in 2010, as well as of oil and meal (cake) processed by cold pressing in 2011

Camelia products	Carbon *(Ci - %)*	Oxygen *(Oi-%)*	Hydrogen *(Hi - %)*	Nitrogen *(Ni - %)*	Sulfur *(Si -%)*	Water *(Wi - %)*	Ash *(%)*	Calorific power *(Qi-kj/kg)*
Seeds	58.9	20,045	8.6	3.7	0.3	4.262	4.193	$2,657x10^4$
Cold oil	75.5	12,6	11.6	0.3	0.0	0,000	0.000	$3,617x10^4$
Seeds meal (cake)	51.0	23,117	7.4	4.7	0.3	6.797	6.686	$2,225x10^4$

The inferior calorific power is the quantity of heat, expressed in calories or other thermal units, liberated by the complete burned of a substance unit in oxygen atmosphere and at constant pressure. The combustion products are gases: carbon dioxide, sulfur dioxide, nitrogen and oxygen, water vapor and ash.

According to table 7, the values of the inferior calorific power of organic Camelia seeds, cold oil and meal (cake), studied by Madalina-Irina Ghilvacs and Tudor Prisecaru in 2012, ranged between 22,25 – 26,57 Mj/kg for meal (cake) and seeds, as well as 36,17 Mj/kg for cold oil. These calorific power values, classify the Camelia seeds besides Anthracite Coal, Camelia meal(cake) besides of Bituminous Coal, and Camelia cold oil besides Jatropha based biodiesel and fuel oil ((NIST Chemistry WebBook)).

Conclusions

1. Camelia seeds contain, mainly, 4,25 – 5,24% ash, 11,06 – 15,24% cellulose, 18,87-21,97% proteins, 30,1 – 49,7% fats, and 25,83 – 28,21 mg/100 g vitamin E (gama tocopherol), as well as minerals – 0,18% Calcium (Ca), 0,53 % Phosphorus (P), 0,49% Cooper (Cu), 1,39 % Manganese (Mn), 4,47 % Iron (Fe) and 2,56 % Zinc (Zn).

2. The Camelia fatts(oil) content depends, mostly, on environment factors – weather characteristics of cropping year and sowing time, as well as on farming system. In our organic yield trial, the best years for Camelia fats(oil) content were 2009 (43,9%) and 2012 (44,2%) and the bad year was 2010 (31,4%). Also, the sowing time effect on fats (oil) content ranged between 29,3 – 46,3% in late autumn and 33,4 – 49,6% in early spring. There appears to be some variation for fats(oil) content among the years and cultivars tested: 31.1 – 45,8% at Camelia, 31,9 – 44,8% at Calena and 30,7 – 43,6% at Lindo. In low input farming system, the fats(oil) content of cultivars studied ranged between 32,7 – 35,9% at Camelia and 29,5 – 33,8% at Lindo.

3. Camelia seeds and oil are very rich in α-linolenic (30,5 – 50,3%), and relatively rich in linoleic (16,60 – 19,27%), and oleic (15,10 – 15,50%) fatty acids. Except the unusual case of trace content of eicosenoic/gadoleic fatty acid of high α-linolenic oil, the Camelia seeds and cold oil have the highest eicosenoic/gadoleic fatty acid content (14,8 – 17,5%).
4. The Camelia α-linolenic fatty acid content of seeds and oil in late autumn sowing time samples is higher when is compared to that of Camelia seeds and cold oil spring sowing time samples.
5. The seeds and cold oil of Camelia contain two essential fatty acid types: Omega(ω)-3 (31,9 – 53,6%) and Omega(ω)-6 (18,6 – 21,61%), as well nonessential Omega(ω)-9 (17,4 – 36,6%) fatty acids.
6. The fatty acids in Camelia seeds and cold oil are principally unsaturated (85,3– 89,4%), with only 9,1 – 11,2% being saturated. More than 55% of the fatty acids are polyunsaturated, primarily linoleic (18:2) and α-linolenic (18:3), and 32% are monounsaturated, primarily oleic (18:1), eicosenoic/gadoleic (20:1), and erucic acid (22:1).
7. The average ω-6:ω-3 ratio of Camelia seeds and cold oil is 1: 1,5 – 2,87, and inverse to the ideal ratio: 3 – 3:1 to 5:1.
8. The ω-6: ω-3 ratio was lower (0,35) and similar to Chia (Salvia hispanica L.) results, only in high α-linolenic oil of Camelia.
9. The fatty acids composition of Camelia seeds and cold oil seems to be not significant different.
10. The Camelia cold oil is susceptible to auto oxidation, thus giving it a shorter shelf life.
11. The calorific power values of Camelia main commercial products, classify the Camelia seeds besides Anthracite coal, the Camelia meal(cake) besides Bituminous coal, and Camelia cold oil besides Jatropha based biodiesel and fuel oil.

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