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Comparative Study on Productivity, Chemical Composition and Yield Quality of Some Alternative Crops in Romanian Organic Farming

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Abstract**—**Crops diversity and maintaining and enhancing the fertility of agricultural lands are basic principles of organic farming. With a wider range of crops in agroecosystem can improve the ability to control weeds, pests and diseases, and the performance of crops rotation and food safety. In this sense, the main objective of the research was to study the productivity and chemical composition of some alternative crops and their adaptability to soil and climatic conditions of the agricultural area in Southern Romania and to cultivation in the organic farming system. The alternative crops were: lentil (7 genotypes); five species of grain legumes (5 genotypes); four species of oil crops (5 genotypes). The seed production was, on average: 1343 kg/ha of lentil; 2500 kg/ha of field beans; 2400 kg/ha of chick peas and blackeyed peas; more than 2000 kg/ha of atzuki beans, over 1250 kg/ha of fenugreek; 2200 kg/ha of safflower; 570 kg/ha of oil pumpkin; 2150 kg/ha of oil flax; 1518 kg/ha of camelina. Regarding chemical composition, lentil seeds contained: 22.18% proteins, 3.03% lipids, 33.29% glucides, 4.00% minerals, and 259.97 kcal energy values. For field beans: 21.50% proteins, 4.40% lipids, 63.90% glucides, 5.85% minerals, 395.36 kcal energetic value. For chick peas: 21.23% proteins, 4.55% lipids, 53.00% glucides, 3.67% minerals, 348.22 kcal energetic value. For blackeyed peas: 23.30% proteins, 2.10% lipids, 68.10% glucides, 3.93% minerals, 350.14 kcal energetic value. For adzuki beans: 21.90% proteins, 2.60% lipids, 69.30% glucides, 4.10% minerals, 402.48 kcal energetic value. For fenugreek: 21.30% proteins, 4.65% lipids, 63.83% glucides, 5.69% minerals, 396.54 kcal energetic value. For safflower: 12.60% proteins, 28.37% lipids, 46.41% glucides, 3.60% minerals, 505.78 kcal energetic value. For camelina: 20.29% proteins, 31.68% lipids, 36.28% glucides, 4.29% minerals, 526.63 kcal energetic value. For oil pumpkin: 29.50% proteins, 36.92% lipids, 18.50% glucides, 5.41% minerals, 540.15 kcal energetic value. For oil flax: 22.56% proteins, 34.10% lipids, 27.73% glucides, 5.25% minerals, 558.45 kcal energetic value.

Keywords**—**Adaptability, alternative crops, chemical composition, organic farming productivity.

I. Introduction

IN global agricultural policies there is concern to find new solutions to problems created by intensively farming techniques of plant and animal growth, to reduce biodiversity related to the vagaries of climate and biotic factors particularly in fragile ecosystems, to maintain and to improve food security and income for poor farmers and subsistence farming. To increase farmers' income requires higher value products which may be obtained by adding value to primary or secondary products. Introduction in the farms of alternative crops and marketing their products can be of real help for farmers and consumers. They may be the way to get food production of high biological quality, and it can represent a special "niche" for food market [1].

In many cases, these "alternative crops" called "neglected" or "underutilised" are the only ones that can survive harsh climatic conditions, unsuitable for other crops that can assure good yields. In this way, they would contribute significantly to biodiversity and to achieve more stable agro-ecosystems [2].

Knowing the nutritional value of alternative food crops, is very important to provide decision support to producers and to motivate consumers to buy such products.

The method of cultivation (including fertilisation, weeds, pests and diseases control) is only one influence on the nutritional quality of a crop. Also known to affect the crop’s quality are factors such as geographical area, soil type, soil moisture, plant variety, weather and climatic conditions, pollution, length of growing season, and post-harvest handling. As many of these factors are beyond the farmer’s control, the method of agricultural practice employed emerges as a significant controllable influence on the quality of a farm’s produce, though clearly other controllable factors such as variety and irrigation/soil moisture can also have significant impacts [3].

Importance of these species results from seeds chemical composition and nutrition value - high contents in proteins and essential aminoacids, mineral elements, lipids - and from the fact they do not have special claims concerning growing conditions, presenting tolerance to diseases and pests, and being able to grow in some harsher climates [4]. On other hand, an important objective of Organic Farming is to maintain and enhance the fertility of the agricultural lands. Therefore, focus is placed upon crop rotation, diversified agricultural crops, increasing pulses crops (peas, beans, soybeans, etc.) and fodder legumes acreage (alfalfa, clover, vetch+oats), increasing green-fertiliser crops (such agricultural crops as lupine, a plant whose biological yields is incorporated into the soil), the employment of the residues from agricultural crops as a source of organic matter for the soil, the

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employment of the animal waste from farms as organic fertilizers [5]. In this context, the present situation of Romanian economy and agriculture is very favorable for the extension of the Organic Farming sector. The Romanian agriculturists are interested to produce such kind of marketable agriculture products and food for domestic and external market.

II. Material and Method

The main objective of the research was to study the productivity, chemical composition and yield quality of some alternative crops and their adaptability to soil and climatic conditions of the agricultural area in Southern Romania and to cultivation in the organic farming system.

Research has been organized in 2009-2011 at Moara Domneasca Experimental Field, located on reddish preluvosoil, for some species of legumes and oil crops. The experiment was organized based on the multi-stage block method with randomized variants, in 4 replications.

The research was set up three field experiments, respectively: an experiment of 7 lentil genotypes („Beluga", „Sorte du Puy", „Laird" (Turkey), „Richlea" (France), „Masoor" (Turkey), „Eston" (Greece), local genotype „De Moara Domnească" (Romanian genotype); an experiment of five species of grain legumes (5 genotypes) (field beans, Greek genotype; chick peas, Greek genotype; adzuki bean, German genotype; black-eyed pea, Slovenian genotype; fenugreek, Romanian genotype); an experiment with four species of oil crops (4 genotypes) (camelina, Romanian genotype; oil flax, Romanian genotype; safflower, German genotype; oil pumpkin, Slovenian genotype.

Seeds came from organic crops from Romania and other European countries, and growing technology was in conformity for organic farming system.

The biochemical compounds (glucides, proteins, lipids and minerals) have been performed by using the specific chemistry laboratory methods: for glucides, Bertrand Method; for proteins, Kjeldahl Method; for lipids, Soxhlet Method; for minerals, Spectrophotometrie Method.

The results were statistically processed by variance analysis.

III. Results and Discussions

Feasibility of a specific crop depends on a number of factors including the suitability of the crop for local growing conditions. Climate, soil characteristics, and damaging organisms problems affect crop productivity [6].

Alternative crops could play a huge role in the world's food supply. They may be less important in comparison to the major crops but they offer much necessary nutritional value and diversity needed in the diet. Studying of nutritional value of the alternative crops in organic farming conditions arising from the very special role it occupies at present this system of agriculture and these plants in the world, Europe and Romania, both in the development of biodiversity, environmental protection, and food diversification [4].

Regarding to results of lentils the yields of the three experimental years illustrates in Table I, prove the suitability of natural conditions in the area and good productivity of organic lentils. Seed production was on average 1343 kg/ha, the limits of variation is 1190 kg/ha for Beluga genotype and 1468 kg/ha for Laird genotype. The most productive genotypes were found to be Richlea and Laird genotypes, who gave average yields of 1486 kg/ha and 1402 kg/ha.

Fig. 1 The lentil genotypes experiment
(Moara Domneasca Experimental Field, 2009)

TABLE I
SEEDS YIELDS OF LENTIL GENOTYPES
(MOARA DOMNEASCA EXPERIMENTAL FIELD, 2009-2011)

Genotypes	Grain yields kg/ha	Grain yields %	Differences (kg/ha)	Significance
Beluga	1190	88.60	-153	ooo
Sorte du Puy	1310	97.54	- 33	oo
Masoor	1290	96.05	-53	ooo
Richlea	1402	104.39	59	***
Laird	1468	109.30	125	***
Eston	1386	103.20	43	***
Moara Domnească	1361	101.34	18	-
Average	1343	100.00	Control	—

$LSD_{5\%}$= 21.5 kg/ha $LSD_{1\%}$= 30.1 kg/ha $LSD_{0,1\%}$= 42.5 kg/ha

Lentil seeds (Table II) contained on average: 22.18% proteins, 3.03% lipids, 33.29% glucides, 4.00% minerals and energy value was 259.97 kcal. The higher protein content were determined in the seeds of Richlea and Laird genotypes, respectively, 22.85% and 22.67%, and protein yields ranged from 248 kg/ha to 326 kg/ha, in average 286 kg proteins/ha.

TABLE II
LENTIL SEEDS CHEMICAL COMPOSITION (% D.M.)
(MOARA DOMNEASCA EXPERIMENTAL FIELD, 2009-2011)

Genotype	Proteins	Lipids	Glucides	Minerals	Energetic value (kcal %)
Beluga	21.78	3.25	32.98	4.11	259.02
Sorte du Puy	21.14	3.40	33.57	4.04	255.86
Laird	22.85	2.95	33.98	3.94	265.00
Richlea	22.67	2.81	33.21	3.91	259.77
Masoor	22.27	3.06	33.43	4.13	263.28
Eston	22.34	3.02	32.87	4.07	258.92
Moara Domneasca	22.21	2.78	33.02	3.84	256.74
Average	22.18	3.03	33.29	4.00	259.97

Lipids content ranged from 2.78% for Moara Domneasca genotype to 3.40% for Puy du Sort genotype and minerals content showed values ranging from 3.84% for Moara Domneasca genotype to 4.13% for Masoor genotype.

Research has also demonstrated that in experimental area and in organic farming system, is possible to harvest yields of 2500 kg/ha of field beans, 2400 kg/the of chick peas, 2393 kg/ha of blackeyed peas, more than 2000 kg/ha of adzuki beans, and over 1250 kg/ha of fenugreek (Table III).

TABLE III
SEEDS YIELDS OF LEGUMES
(MOARA DOMNEASCA EXPERIMENTAL FIELD, 2009-2011)

Species	Grain yields		Diferences (kg/ha)	Significance
	kg/ha	%		
Field beans	2500	118.48	390	***
Chick peas	2400	113.74	290	***
Blackeyed peas	2367	111.84	257	***
Adzuki beans	2000	94.78	-110	ooo
Fenugreeak	1250	59.24	-860	ooo
Average	2110	100.00	Control	–

$LSD_{5\%}$= 68 kg/ha $LSD_{1\%}$= 103 kg/ha $LSD_{0,1\%}$= 166 kg/ha

Fig. 2 The legumes crops experiment
(Moara Domneasca Experimental Field, 2010)

For other legumes, it can highlight that the proteins content was over 21%, the highest content was analized in blackeyed peas seeds (23.30%). The lipids content oscilated between 2.10% at blackeyed peas and 4.65% at fenugreek. Highest glucides content and energetic value were recorded at adzuki bean of 69.30% and, respectively, 402.48 kcal%) (Table IV).

The research showed that oil crops in organic farming system can produce 2200 kg/ha of oil flax, 2150 kg/ha of safflower, 1518 kg/ha of camelina, 570 kg/ha of oil pumpkin, (Table V).

Related to the chemical composition of oil crops yields (Table VI), at oil pumpkin was found a proteins content of 29.5%; this species was followed by oil flax with 22.56% proteins, and the lowest values were determined for the safflower, of 12.60%. Camelina seeds had intermediate protein contents of 20.16%. Oil content of the studied species ranged between 28.37 and 36.92%. Slightly lower oil content resulted for safflower and camelina (28.63 and 31.61%), and the highest (34.10 and 36.92%), were registered for pumpkin and flax oil.

TABLE IV
LEGUMES SEEDS CHEMICAL COMPOSITION (% D.M.)
(MOARA DOMNEASCA EXPERIMENTAL FIELD, 2009-2011)

Genotype	Proteins	Lipids	Glucides	Minerals	Energetic value (kcal %)
Field beans	21.50	4.40	63.90	5.85	395.36
Chick peas	21.23	4.45	53.00	3.67	348.22
Blackeyed peas	23.30	2.10	68.10	3.93	350.14
Adzuki beans	21.90	2.60	69.30	4.10	402.48
Fenugreeak	21.30	4.65	63.83	5.69	396.54

TABLE V
SEEDS YIELDS OF OIL CROPS
(MOARA DOMNEASCA EXPERIMENTAL FIELD, 2009-2011)

Species	Grain yields		Differences (kg/ha)	Significance
	kg/ha	%		
Camelina	1518	94.32	-91.5	oo
Oil flax	2200	136.69	590.5	***
Oil pumpkin	570	35.41	-1039.5	ooo
Safflower	2150	133.58	540.5	***
Average	1609.5	100.00	Control	–

$LSD_{5\%}$= 55 kg/ha $LSD_{1\%}$= 83 kg/ha $LSD_{0,1\%}$= 133 kg/ha

Fig. 3 The oil crops experiment
(Moara Domneasca Experimental Field, 2011)

Energy values of the oil crops ranged from 423.78 kcal at safflower to 558.45 kcal for flax oil. Oil pumpkin and camelina had intermediate energy values of 540.15 kcal, 525.54 kcal respectively.

TABLE VI
OIL CROPS SEEDS CHEMICAL COMPOSITION (% D.M.)
(MOARA DOMNEASCA EXPERIMENTAL FIELD, 2009-2011)

Genotype	Proteins	Lipids	Glucides	Minerals	Energetic value (kcal %)
Camelina	20.16	31.61	36.30	4.30	525.54
Oil flax	22.56	34.10	27.73	5.25	558.45
Oil pumpkin	29.50	36.92	18.50	5.41	540.15
Safflower	12.60	28.37	26.41	3.60	423.78

IV. CONCLUSION

Research carried out in 2009-2011 have shown the adaptability of legumes species (lentils, field beans, chick peas, blacheyed peas, adzuki beans, fenugreek) and oil crops (safflower, oil pumpkin, flax oil and camelina) in terms of agricultural area in Southern Romania and possibility of these crops cultivation in organic farming system, in order to diversify the range of crops and achieve correct rotation in which legumes are particularly important as ameliorative crops. However, the introduction and these species expansion may contribute to the diversification of food and animal feeding.

In today's world, professionals are increasingly turning attention more towards the study of plants less known and less commonly grown, but are possible alternatives to species already used. Thus, some oil crops (e.g. safflower, camelina, pumpkin, etc.) and some legumes (e.g. lentils, field beans, chick peas, etc.) less cultivated in the Romania can become alternatives by the important role in developing and diversifying agricultural production, the range of foods, in general, and for a sustainable agriculture.

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