Organic goat meat production in less favoured areas of Romania

Maria Sauer*, Ioan Padeanu**, Neculai Dragomir**, Elena Ilisiu***, Gerold Rahmann****, Walter-Ioan Sauer*, Sorin-Octavian Voia**, and Dinu Gavojdian*

Abstract

More than 1.2 million goats are currently being reared in Romania today, with the numbers rapidly increasing. Moreover, the country holds 4.9 million hectares of pastures, mostly situated in regions listed as less favoured areas (LFA's). A comparative study showing production performances of two pasture types (organic vs. conventional), and of two kids genotypes (Carpatina vs. F_1 Boer x Carpatina) was implemented. The annual pasture yields were 26.4 t/ha (5.3 t/ha/a DM) in the conventional pasture and of 30.6 t/ha (6.1 t/ha/a DM) in the organic managed pasture, respectively. The average carrying capacity was 1.89 livestock units (LU; one LU is equal to 500 kg liveweigth) for the conventional pasture, and 2.18 LU for the organic pasture, respectively. The conventional pasture had an estimated potential of production ranging from 114 to 163 kg of kid meat/ha, while the estimated production for the organic pasture was between 149 and 252 kg of kid meat/ha. Result have proved to be encouraging regarding the potential of the LFA's in Romania to produce goat meat under organic rearing systems with purebreed genetics. Of the technical solutions identified, those regarding pasture management could be applicable to current commercial farming practices in order to improve goat farming profitability while at the same time tackling socio-ecological issues such as nature conservation and animal welfare.

Keywords: *goat meat, organic production, Romania, extensive grazing systems, crossbreeding, Boer goats, Carpatina goats*

Zusammenfassung

Ökologische Ziegenfleischproduktion in benachteiligten Regionen in Rumänien

In Rumänien werden mehr als 1,2 Millionen Ziegen gehalten, Tendenz steigend. Weiterhin gibt es rund 4,9 Millionen Hektar Weideland, das meiste liegt in benachteiligten Regionen. Es wurde eine vergleichende Studie auf zwei unterschiedlichen Weidequalitäten (ökologisch und konventionell) mit zwei unterschiedlichen Genotypen (reinrassige lokal verbreitete Doppelnutzungsrasse der Karpatenziege sowie ein Kreuzung dieser Rasse mit der Fleisch betonten Burenziege) durchgeführt. Die Tragfähigkeit wurde mit 1,89 Grossvieheinheiten (GV; eine GV entspricht 500 kg Lebendmasse) für die konventionellen Flächen und 2,18 GV festgestellt. Pro Hektar konnten auf den konventionellen Flächen zwischen 114 und 163 kg und auf den ökologischen Flächen 149 bis 252 kg Ziegenfleisch pro Jahr produziert werden. Die Kreuzungslämmer erreichen mit rund 154 g fast 40 Gramm höhere Tageszunahme als die reinrassigen Karpaten-Ziegenlämmer (117 g/d). Damit zeigte sich, dass es ökonomisch sinnvoll ist, die Flächen ökologisch zertifiziert mit Kreuzungsziegenlämmern zu nutzen, wenn es einen Markt für Prämiumqualitäten (Öko-Zertifkat) gibt. Damit wird nicht nur die Wirtschaftlichkeit sondern auch der Umweltschutz und das Tierwohl verbessert.

Schlüsselwörter: *Ziegenfleisch, Ökologischer Landbau, Rumänien, extensive Weidewirtschaft, Kreuzungszucht, Burenziege, Karpatenziege*

* Romanian Academy for Agricultural and Forestry Sciences, Research and Development, Station for Sheep and Goats Caransebes, Resitei Street, 325400 Caransebes, Caras-Severin County, Romania

** Banat's University of Agricultural Sciences and Veterinary Medicine 'King Michael I of Romania', Faculty of Animal Science and Biotechnologies, 119 Aradului Street, 300645 Timisoara, Timis County, Romania

*** Romanian Academy for Agricultural and Forestry Sciences, Research and Development, Station for Sheep and Goats Reghin, 11 Dedradului Street, 545300 Reghin, Mures County, Romania

**** Johann Heinrich von Thünen Institute, Institute of Organic Farming, Trenthorst 32, 23847 Westerau, Germany

Contact: gavojdian_dinu@animalsci-tm.ro

1 Introduction

The organic farming sector in the EU has been rapidly developing during the past decades. In 2011 a total area of 9.6 million ha were cultivated as organic, compared to 5.7 million ha in 2002 (Eurostat, 2014). During the last decade, organic area in the EU improved by about 500,000 ha per year, with the whole organic area representing 5.4 % of total utilized agricultural area in Europe (DG-AGRI, 2013).

The organic goat sector within the EU accounts for 0.4 million heads, concentrated geographically in Greece (4.1 % of goats reared in Greece) and Italy (7.5 % of the national flock), with the farmers essentially focused on organic cheeses production (DG-AGRI, 2013).

In Eastern and Southern Europe, the majority (over 85 %) of the sheep and goats flocks are being reared in mountainous and disadvantageous areas, called Less Favoured Areas (LFAs) as defined in Dir.75/268/EEC, having an important economic, social and ecological role, and also contributing to the conservation of the environment (Sossidou et al., 2013).

Currently, Romania has a national flock of 9.5 million sheep and 1.2 million goats (MADR, 2014), with numbers increasing by 5 to 8 % each year for both species in the last 5 years. Moreover, the country has a pasture surface of 4.9 millions ha, which could sustain a flock of up to 16 million sheep and goats (Dragomir, 2009). Sheep and goats are being reared in Romania almost exclusively under extensive low-input production systems, with the breed structure being dominated by indigenous rustic breeds, such as the Turcana (52.4 %) and Tsigai (24.3 %) in sheep (Ilisiu et al., 2013) and Carpatina (over 80 %) in goats (Pascal et al., 2011). With the goat production being orientated primarily towards the milk production, while the kid meat is regarded as a marginal product. The Carpatina goat is regarded as low performing, however the breed has a remarkable organic resistance and adaptation. Reports concerning performance of Carpatina breed have shown modest production levels, with milk yields estimates of 240 to 260 kg/lactation (Padeanu, 2001) and growth rates in kids as low as 94 g/day (Voia et al., 2010).

Although Romania holds around 10 % of the goat flocks reared in the EU, with the industry representing an important sector of the agriculture at national level, research on organic goats production systems is lagging behind, compared to that from other states. Up-to-date, the importance of organic farming in Romania has remained limited, especially in the animal production sectors (dairy, meat and eggs), with significant progress being made for crops and horticulture in the last five years. Given the high production potential (large surface of natural pastures, the increasing numbers of sheep and goats, great number of LFA's, consolidated foreign markets), in the European Agricultural Fund for Rural Development (EAFRD) programs for Romania, the organic farming was set-out as a priority for local development, with several measures and types of funding's addressing investments in the organic animal production sector and being available for the 2014 to 2020 period. Moreover, the Romanian goat breeders could take advantage of the EU developed schemes such as PDO (protected designation of origin), PGI (protected geographical indication) and TSG (traditional speciality guaranteed), having in mind that the government and the EU are subsidizing up to 50 % the market-placement activities of such products, starting 2012 according to Council Regulation EC 3/2008 and translating national law and regulation in place. Thus, traditional products such as the goat meat ‚virşli' sausages, could be promoted and protected, bringing added value into the sector, and creating premises for further development.

However, the low purchasing power of the local consumers and the consideration of the general public that the small ruminants production systems are environmental- and animal-friendly, are the two main constraints for the future development of the organic goat meat production in Romania in particularly, and Eastern and Southern Europe in general.

Starting year 2011, the Research and Development Station for Sheep and Goats from Caransebes of the Romanian Academy for Agricultural and Forestry Sciences began implementing a research programme on organic sheep and goats farming. The main objective of the project was to explore and identify technical solutions to the specific constraints of organic sheep and goats farming linked to reproduction performances, feeding strategies and management, animal health and welfare.

The aim of the current research was to evaluate the technical efficiency and viability of introducing the organic goat meat production in less favoured areas of Romania.

2 Materials and methods

2.1 Location and animals

The trial was initiated starting autumn 2013 at the Research and Development Station for Sheep and Goats from Caransebes (45°25'N/22°13'E). Caransebes region has a typical Central European humid continental climate, with the research station being located at an elevation of 280 m above sea level and a total annual precipitation of 737.2 mm, with a mean annual temperature of 12.9 °C. Temperatures express seasonal patterns with summer daily means of 20.1 °C in July and winter daily means of -0.8 °C in January (Table 1).

The project herd consisted of 90 multiparous purebred Carpatina does, managed under organic rearing conditions as stipulated by the Council Regulations of the European Comission (2092/1991/EEC and 1804/1999 EEC) on standards of organic animal husbandry. Two breeding herds were set-up, with half of the does (n = 45), randomly selected being mated with Carpatina purebred bucks, while the second group of does were exposed to Boer bucks. Buck/doe ratio was roughly of 1:20, for two consecutive oestrous cycles (42 days), with the reproduction season starting in mid September. Nutritional flushing was practiced for three weeks before the mating seasons, in addition, all animals had free access to potable water and mineral blocks year around. Animals were housed indoors during winter for a period of 120 days, on deep straw bedding, with a space allowance of 1.8 m^2 and 0.5 m^2 per doe and kid, respectively. Does received high-quality clovers and pastures hays *ad libitum*, with an additional 200 g of concentrates in late gestation and during suckling period. All hays and concentrates were organically produced on farm. Creep feeding of kids was not practiced, they were solely reliant on the dams milk production. Kids were weaned at 60 days of age.

Table 1

Experimental design and general management conditions

Location:	45°25'N/22°13'E	Altitude of the site:	280 m
Annual precipitation:	737.2 mm	Mean annual temp.:	12.9 °C
Breeding herd:	90 Carpatina does	Buck/doe ratio:	1:20
Indoor housing:	120 days	Kids weaned at:	60 days
Pasture management:	rotational grazing	Kids /experiment:	80
Kids /group:	40 (sex ratio 1♂:1♀)	Kids genotype / group:	20 CA /20 F_1BC

After weaning (April, 2014), kids were divided into two groups of 40 individuals each (20 Carpatina purebreds and 20 F_1 Boer x Carpatina), balanced for body weights and sex among groups and genotypes. Group I was managed under conventional conditions, on a cultivated pasture (control group). Group II was managed under organic-pasture conditions (experimental group). Both groups were kept exclusively on pasture for a period of four months, with a gradual transition from indoor housing to pasture of 10 days. Rotational fenced grazing was practiced, each of the two pastures having 6 identical in size areas (1600 m^2). Kids were provided on pasture with shelter and shade, and had non-restricted access to water and mineral blocks.

The research activities were performed in accordance with the European Union's Directive for animal experimentation (Directive 2010/63/EU).

2.2 Pasture management

In order to evaluate the potential of producing organic kid meat in western Romania, under pasture-based extensive system, a comparative study between two pasture types was implemented. One managed and fertilized conventionally (CONV), and one organic managed pasture (ORG), which was subject to a conversion period of two years (2012 and 2013).

The CONV pasture was fertilized initially in two stages, first in early spring 2012 with a dose of $N_{100}P_{70}K_{70}$, and secondly, after the first harvest with a dose of N_{50}. In 2013, fertilization was made by administrating N_{100} in early spring and N_{50} after the first harvest. During both years, the pasture was used to produce bailled hay, and was not used for grazing. The following plant species were identified within the pasture: grass 59 % (*Lolium perenne*, *Festuca pratensis* and *Festuca arundinacea*), legumes 2 % (*Lotus corniculatus* and *Trifolium repens)* and other species 39 %.

The ORG pasture was fertilized in early-spring 2012 by direct grazing with the animals, at a stoking rate of 1 goat/1.5 m^2, kept for four consecutive nights. After the animals removal from the pasture, minimum tillage works were done and the pasture was over-seeded using a mix of grasses and legumes having the following structure: *Lolium perenne* 40 % (8 kg/ha); *Festuca pratensis* 30 % (6 kg/ha); *Festuca arundinacea* 10 % (2 kg/ha); *Lotus corniculatus* 10 % (2 kg/ha); *Trifolium repens* 10 % (2 kg/ha). During the conversion period, the pasture was used to produce hay, and not directly grazed by animals.

Grass availability (DM/ha) was measured monthly using twelve iron-fenced net boxes (1.5 × 1.5m, 1m height), randomly placed on grazing area, according to the method described by Napolitano et al. (2011). Herbage was harvested at ground level from three 1 × 1m areas placed into boxes. The total herbage mass was weighted and subsampled to evaluate dry matter and chemical composition and to estimate the botanical composition.

In 2014, both conventional and organic pastures were fenced using net wire fencing of 150 cm height. With the distance between the CONV and ORG pastures being of 200 m, in order to avoid as much as possible differences in pasture yields caused by soil type and fertility.

2.3 Data collection

In Carpatina does the conception rate (%), litter size (%) and litter weight gain at 28 days of age (kg) was recorded. Conception rate was calculated as the ratio between the number of does kidding relative to the total number of the does exposed to the buck. Litter size (prolificacy) was computed as the ratio between the number of kids obtained relative to the number of does kidding. Litter weight gain at 28 days of age was calculated by subtracting the litter weight at birth from the litter weight at 28 days.

Individual kid records were made by identifying the birth type, ear-tag number, birth weight and date, dam and sire genotype, weight at 28, 60, 90, 120, 150 and 180 days. Survival rates of kids from birth to weaning (60 days of age) was recorded.

Body weight was monitored using the electronic Inscale Platform Scale EOE 150 K 100 XL equipped with an animal weighing programme, in the morning at the same hour on each day, in order to obtain the highest accurate data.

Data were statistically using MiniTab14 software and differences between groups were analyzed by non-parametric Mann–Whitney–Wilcoxon test. All decisions about the acceptance or rejection of statistical hypothesis have been made at the 0.05 level of significance.

3 Results and discussion

Carpatina does on this project were at the upper end of the range for fertility rates (estimates of 80 to 95 %) previously reported for meat goats (Malan, 2000; Rhone, 2005; Browning et al., 2011). Furthermore, the current study represents the first report of fertility rates for Carpatina does (Table 2).

Table 2
Mean (± SEM) for does reproductive performance and kids survival rates

Conception rate (%):	92.2	± 0.28	Litter size (%):	146.9	± 0.57
Birth weight CA (kg):	3.67	± 0.06[a]	Birth weight F_1BC (kg):	4.24	± 0.11[b]
CA weight at 28 d (kg):	8.07	± 0.11[a]	F_1BC weight at 28 d (kg):	10.1	± 0.16[b]
ADG in un-weaned CA (g)	117.4	± 0.01[a]	ADG in un-weaned F_1BC (g)	154.0	± 0.01[b]
Survival rate CA (%):	91.3	± 0.37[a]	Survival rate F1BC (%):	88.7	± 0.40[a]

[a,b] Column means with different superscripts differ significantly at p ≤ 0.05;
ADG – average daily gain

Reproductive outputs is the production traits with the greatest impact on profitability in commercial meat goat farms.

Litter size of the experimental flock was lower than previous estimates and reports by Duricic et al. (2012) for does managed semi-intensively and those of Rahmann (2009) for does reared under organic production systems, respectively. However, the litter size of 146.9 % is within the limits for the breed's standard, of 130 to 160 % (Voia, 2011).

Boer-sired kids were heavier (p ≤ 0.01) at birth compared with those produced by Carpatina sires (4.24 vs. 3.67 kg). Birth weight of the F_1 Boer x Carpatina kids was higher than previous data reported by Duricic et al. (2012) for Boer purebreds, the higher litter size of the Boer does (180 %) could have resulted in individual lower weights at birth.

Significant differences between the adult average body weights of the two breeds was a reason for concern at the beginning of the project. Given that Carpatina does weigh between 40 to 45 kg, while adult Boer bucks weight is of 110 to 120 kg. Although kids sired by the Boer bucks were heavier, no dystocia or other related birth problems were recorded during the kidding season. Worth mentioning that the breeding heard was consisting exclusively out of multiparous Carpatina does (3 to 4 parity).

Overall, reproductive performance of the Carpatina does is not suitable for the meat production. For the breed to become a potential maternal-breed to be used in future crossbreeding schemes with meat specialized bucks (e.g. Boer, Kiko), intense selection for prolificacy and milk-ability is recommended.

Genotype influenced significantly (p≤0.01) kids weight at 28 days of age, with F_1 Boer x Carpatina crossbred kids outperforming the Carpatina purebreds. Although kids dams were of the same breed, and presumably had the same milk-ability, the higher birth weight of the crossbreeds might contributed to the higher growth rates during the first 28 days.

Average daily gain of F_1 Boer x Carpatina kids was significantly (p ≤ 0.01) higher than their counterparts, the Carpatina purebreds, with average values of 154.0 g/day and 117.4 g/day, respectively. Results are in accordance with those reported by Belay et al. (2014), on using Boer bucks as terminal sires for improving kid growth rates.

Survival rates of kids till the age of weaning was not affected (p ≥ 0.05) by sire's genotype, although Carpatina kids outperformed slightly the crossbreeds. This indicator could prove useful for Romanian farmers which plan to use Boer bucks for crossbreeding with native breeds and populations, in order to improve growth rates and carcass quality of lambs.

Despite encouraging prospects, the application of innovative pasture cropping systems is encountering difficulties due to the lack of technical information and solutions regarding the correct management of organic pastures for the small ruminants sector (Ronchi and Nardone, 2003).

During the third year of vegetation, at the end of the conversion period, the organic managed pasture yield was of 30.6 t/ha, compared to the 26.45 t/ha crop, estimated for the conventional managed pasture (Table 3). Overall, the increase in production of 15.6 % for the organic pasture could be attributed to the legumes species incorporated in the initial over-seeding, and to the annual rain falls registered in 2014, of 900.8 mm, which are were with 30 % higher than the average annual rain falls for the region.

Table 3
Estimates on the organic and conventional pastures yields (3rd year of vegetation)

Production trait	Conventional	Organic
Pastures yields (t/ha)	26.45	30.60
Dry matter (t/ha)	5.29	6.12
Pastures crude protein production (kg/ha)	813	987
Biological nitrogen fixation (BNF), (kg/ha)	22	65
Pastures carrying capacity (animal units)	1.89	2.18

The incorporation of legumes (*Trifolium* and *Medicago* spp.) into organic managed pastures, leads to an improvement of both pasture yields and nitrogen fixation, as previously demonstrated by Caporali and Campiglia (2001). The organic pasture has yielded a crude protein production superior with 21.4 % compared to the conventional managed pasture, average estimates being of 987 kg/ha and 813 kg/ha, respectively.

Higher protein content of a pasture has a series of benefits, such as allows a higher stoking rate, has the potential to produce better quality hays, the palatability rises, and thus the selective grazing is reduced. Nitrogen fixation in soil has significant implications for both the small ruminant industry as well for the environment protection. During the current study, the biological nitrogen deposited in soil was of 22 kg/ha for the conventional pasture, while for the organic pasture, the nitrogen deposited in the soil was of 65 kg/ha, resulting a three folded quantity of nitrogen deposited in the soil per hectare. The higher pasture yield for the organic pasture, compared to the conventional managed pasture, could be attributed to the following three aspects:

i) seeding and pasture plant structure, which for the organic pasture had a initial legumes proportion of 20 %, compared to the 2 % in the conventional pasture (being known that the white clover is self-seeding easily and invasive towards grass species), with the organic pasture being in its 3rd year of vegetation, when most cultivated pastures are reaching their production peak;

ii) the nitrogen available in soil, which constrains significantly plants growth and thus, pasture yields, with several studies outlining that the legumes nitrogen deposited in soil has a superior plant availability and absorption rates, compared to synthetic nitrogen used in the conventional system;

iii) in addition, the higher levels of rain falls registered during 2014 (+ 30 % than the average for the region), might have caused a significant higher growth rates of the plants, favoring the cultivated species from the organic pasture. Most-likely, all three factors mentioned above have concurred to the unexpected results concerning the two pastures yields. Giving the organic's pasture higher yield, the carrying capacity (animal units) was higher with 15.3 %, compared to the conventional pasture.

Under pasture conditions, the Carpatina kids had growth rates of 100.7 g/day and 105.2 g/day, under conventional and organic systems, respectively (Table 4). Pasture type did not influenced ($p > 0.05$) growth rates in the purebred kids. While for the F_1Boer x Carpatina kids, the pasture type influenced significantly ($p \leq 0.05$) the growth rates, with average values of 145.2 g/day and 177.3 g/day being recorded in the conventional and organic systems, respectively.

Table 4
Data on growth rates performances and on kids

Trait	Conventional	Organic
ADG on pasture in Carpatina kids (g)	100.7 ± 0.02^a	105.2 ± 0.03^b
ADG on pasture in F1BC (g)	145.2 ± 0.02^a	177.3 ± 0.03^b
Meat production estimates in CA kids (kg/ha)	114 kg	149 kg
Meat production estimates in F_1BC (kg/ha)	163 kg	252 kg

Based on both kids growth rates and pastures production yields, the potential of meat production for the two genotypes and two pasture types was estimated. The conventional pasture from the current project had a potential of production of 114 kg/ha for Carpatina purebreds, and of 163 kg/ha for F_1 Boer x Carpatina crossbreed kids. While for the organic pasture, it was estimated a production potential of 149 kg of meat per ha while rearing Carpatina purebreeds, and of 252 kg/ha for the Boer x Carpatina dual-breds. Current results are in accordance with reports of Mbuku et al. (2015), which found that throughout crossbreeding, the improvement of meat production rises with 18.2 kg per doe mated per year, compared to using dairy purebreeds. Nutritional strategies in low cost and easy to apply in pasture based systems can improve the productive performance of goats and have the potential to lead to profitable and successful enterprises.

The technical efficiency and viability of organic and conventional meat goat production were investigated (Table 5). Overall, the production costs in the organic production system were greater, when compared with the conventional management of the pasture. With the pasture seeding costs being higher with 40.6 %, and those of price/t of pasture of 25.8 % for the organic pasture, compared to the conventional system.

Estimated production costs per kg of kid meat were higher by 12.6 % when rearing Carpatina purebreeds, and by 35.3 % when F_1BC crossbreeds were concerned. Altogether, higher production costs should reflect in the economic returns (EUR/kg of sold kid), in order for the farmers to adopt the organic production systems. This could be achieved either throughout niche marketing of organic goat meat products (e.g. development of PDO or PGI labelled food products), or by governmental policies and introduction of subsidies schemes into the sector to aid its development.

Table 5
Technical efficiency of organic production of goat meat

Costs categories (in EUR)	Conventional	Organic
Pasture seeding costs /ha	191.90	269.96
Production costs /t of pasture	6.97	8.77
Annual pasture maintenance costs /ha	83.23	128.23
Production costs /kg of meat CA	2.37	2.67
Production costs /kg of meat F1BC	1.16	1.57

Rahmann (2007) in his work concerning the economic returns in dairy and meat goat sectors, has shown that farm profitabilty differs to a great extent, with an average annual income of 163 EUR/doe raised for milk production, while the returns for meat goats was of 36 EUR/doe.

However, rearing goats for meat offers a set of advantages, when compared to dairy goats, such as: management in meat animals is less dependant on infrastucture and investitions; the labour costs are being significantly reduced; no need for inveting in miling parlors and milk coolonig tanks; the posibility of using transhumance for landscape management; lower veterinary care and energy costs.

4 Conclusions

Current results have proved to be encouraging regarding the potential of the Less Favoured Areas from Romania to produce goat meat under organic rearing systems. Technical solutions identified, regarding pasture management might have applicability in current commercial farming practices, in order to improve goat farming profitability, in the same time tackling environmental issues.

Introduction and use of the South African Boer meat specialized breed into crossbreeding schemes with local unimproved goat populations has lead to a significant increase of both growth rates and kid meat production per hectare.

Taking advantage of the Boer meat producing potential, the local low-input breeds high levels of adaptation and organic resistance, and also of the heterosis effects.

However, both farmers and policy makers should be aware and keep in mind both the unconsolidated markets for organically kid meat found in Eastern Europe, as well as the volatility of the small ruminants meat markets and demand.

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