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Meat from young goats raised in Argan Tree Forest (Morocco): Emerging product to valorise

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SUMMARY – During the past few years, the ecology of Argan tree forest (800 000 ha in SW Morocco) and the argan oil have been studied extensively. Goats, particularly the rearing of yearling males, constitute an important component of the argan farming system. Young goats are reared outdoors on the argan rangelands without conventional concentrate supplies, except some argan by-products. Recent experiments supported by the PRAD programme (PRAD 0011) showed that in comparison with an indoors feeding (usual system in Morocco) the meat produced by argan tree grazing, supplemented or not, presents lower lipids and cholesterol contents, higher proportions of $n-6$ and $n-3$ (PUFA) and a lower $n-6/n-3$ PUFA ratio, which results in beneficial characteristics for human health. The meat of these goats is appreciated mainly by local consumers: this was confirmed by the sensory panels during the experiments. But, in Morocco, the frequency of cardio-vascular diseases is progressing and consumers are tending to coming back to traditional products. Kids raised in the Argan area present the characteristics to cover the demand of Moroccan consumers in the future. Due to the limited number of carcasses produced, this meat could be only a niche product. For developing its market, it would be better to organize the production and trade chain by setting up goat farmers groups and an organization involving all partners such as slaughterers and butchers.

Keywords: Argan tree forest, goat meat, young goat, dietetic quality, fatty acid composition, typical product.

RESUME – "La viande de chevreaux élevés en Arganeraies (Maroc): un produit émergent à valoriser". Pendant ces dernières années, l'écologie de la forêt d'Arganiers (800 000 ha dans le SO du Maroc), et de l'huile d'Argan a été étudiée de façon approfondie. L'élevage de caprins, en particulier de jeunes mâles, constitue une importante composante du système agraire de l'Arganeraie. Généralement, les chevreaux sont élevés à l'extérieur sur les parcours, sans apport de concentré excepté les sous-produits de l'Arganier. Des recherches récentes soutenues par le programme PRAD (PRAD 0011), montrent qu'en comparaison avec le système d'alimentation classique au Maroc à base essentiellement de concentré, la viande produite sur le pâturage de l'Arganeraie avec ou sans concentré présente des teneurs plus basses en lipides et en cholestérol dans les muscles, une proportion plus élevée d'acides gras polyinsaturés (AGPI) en $n-6$ et $n-3$, et un rapport AGPI $n-6/n-3$ plus faible. Ces caractéristiques sont favorables pour la santé humaine. A présent, la viande de caprins élevés en Arganeraie est principalement appréciée par les consommateurs locaux. Cela confirme les résultats de panels de consommateurs réalisés pendant ces expériences. En outre, au Maroc, les maladies cardio-vasculaires progressent et la nouvelle tendance des consommateurs est de revenir à des produits traditionnels. Les chevreaux élevés en Arganeraie présentent des caractéristiques pour répondre à la demande des consommateurs marocains à l'avenir. En raison du nombre limité de carcasses produites, le marché de ce produit se limite à une niche commerciale. Pour développer ce marché, il serait nécessaire d'organiser sa filière en créant des groupes d'éleveurs et en mettant en place une structure représentant tous les acteurs de la filière.

Mots-clés: Arganeraie, viande caprine, chevreau, qualité diététique, composition en acides gras, produit typique.

The Argan ecosystem

Argan forests occupy an area of 800,000 ha and contain around 26 to 30% of the Moroccan goat population (El Aïch, 1995). The Arganeraie is a three-component farming system based on barley, Argan tree and goats. Barley has several functions: it is a staple diet of the people, and its straw, thatch (stubble), and grain are also used as animal feed. The second component, the Argan tree (which doubles as a fodder and fruit tree), constitutes the heart of this agrarian system. The local

population of goats makes up the third component. The meat goat production made up an important part of the incomes of goat breeders. Goats and particularly the rearing of yearling male goats constitute an important component of the Argan farming system. Usually, young goats are reared outdoors on the Argan rangelands without conventional concentrate supply, except some Argan oil by-products. Boscher (1992) estimated that Argan forest and Argan by-product, notably the pulp of the fruit named "alig", contributed to 50% of goats' nutritional needs.

The problem statement

In Arganeraie, goats are considered as rustic animals. They take less advantage of the supplementary feeds as compared to the other animal species. Most of their feed comes from grazing areas (75 to 80% of their needs). Bousquet (2000) pointed out the predominance of grazing in the Argan forest, especially from August to December. The high variability of the contribution of Argan trees to goats' diets according to the different grazing areas as well as to the climatic nature of the year were underlined by Person (1998), El Aïch (1995) and Bousquet (2000). Indeed, during the dry periods the feed supply coming from Argan tree forest could be not sufficient to meet energy and nitrogen requirements for maintenance and growth. In these conditions, the goat breeders were forced, either to sale a part of their livestock or to give Argan by-products.

Consequently, from the findings of this research the goat as it is raised in the Argan area presents all the characteristics of typical product or niche product. Therefore, we got to reason the following question: Is the goat meat produced in Argan forests adapted to the new requirements of Moroccan consumers, particularly in towns, owing to its dietetic quality?

The typicity of the meat of goats from the Argan area

Argan niche

The Argan tree (*Argania spinosa*) is an endemic tree found in the South-western part of Morocco. In this region, the Argan forest is also important in terms of the conservation of the environment and for the local economy by supplying wood for heating, forage and meal for animal feeding and oil extracted from nuts for human food and cosmetic products. The major income of goat farmers is derived from the sale of live goats and Argan goat farming is predominant because goats use Argan tree products (leaves, nuts) as main components of their diet and browse trees when herbaceous resources are limited (El Aïch, 1995; El Aïch *et al.*, 2006). When resources from Argan trees cannot meet the maintenance and growth requirements of goats, goat farmers sell a part of their flock or supply Argan by-products.



Fig. 1. Local "Haha" goats grazing into Argan trees.

Goat population

"Haha" goats are known for their ability of climbing Argan trees (Fig. 1). The learning of the young animals (less than 3 months) by older ones is predominant. According to livestock holders, goats coming from other areas never climb into the Argan trees. Climbing ability of goats depend on the physiological stage. Indeed, gestating goats, old goats and bucks during mating season never climb into the trees to graze. Falls of goats from the trees are frequent. According to holders, 10 to 30% of goats broke their legs as result of falls from the trees.

Husbandry and feeding systems

According to a survey realised in the Tamanar area, there are 3 types of goat holders (Bousquet, 2000). Presentation of these three types of husbandry systems is provided in Table 1. Feeding systems depend on many interacting factors such as:

(i) The availability of supplementary feeds (Argan by-products and concentrate) that impacts directly the grazing activities of goats;

(ii) The availability of other pastoral resources (herbaceous layer) and agricultural residues (straw and stubble) determined the contribution of Argan trees to goat feeding.

(iii) The availability of sylvo-pastoral resources that are controlled by the socio-economical management as well as the access to these resources (El Aïch *et al.*, 2005).

Table 1. Husbandry and feeding systems in Tamanar (region of Essaouira) (Source: Fiat, 1989)

Types	Small holders (20 to25 %)		Medium holders (65 to 70%)		Large holders (<10%)
Size of goat flock (>1 year)	15-20	30-40	40-80	60-100	>100
Size of sheep flock	<10	30-40	<10	30-40	50-100
Herding	Family's members	Family's members	Family's members	Family's members or salary workers	Family's members or salary workers
Other feed supplies	No other feed	During droughts	During droughts	During droughts, and priority to sheep	During droughts, and period of feed shortage
Product: meat	Kids and culled animals	Kids and culled animals	Kids and culled animals	Kids and culled animals	Kids and culled animals and castrated bucks

Feed resources that contribute to goat diet are very diverse. Overall, total contribution of Argan trees (leaves and fruits) ranged from 47 to 84% according to the period of the year. Argan leaves are the main component of goat diet along the year (35 to 68%). Argan fruits are consumed from April to June. Other plant species have seasonal contribution. For instance, herbaceous species that responded to rain are consumed during early spring. Oleastre leaves are mainly consumed during late season (September to December) when the under trees layer availability becomes short.

Typical meat quality

Studies conducted (Bas *et al.*, 2005) shown that meat from goats which had access to the Argan forest for grazing, could be differentiated from that of goats fattened indoor, by a specific fat and fatty

acid profile (Table 2). This difference of composition expressed on the one hand, a more intense ruminal activity, and in the other hand a diet richer in polyunsaturated fatty acids (PUFA). The higher content of PUFA of the serie *n*-3 and the lower percentage of palmitic acid in the meat of goats which could graze in the Argan forest result in a favourable composition for consumers' health. Moreover, the concentrate supply to the goats which could graze in the Argan forest had a beneficial effect on growth rate, but had low effect on fat depot weights and on fatty acid composition of adipose tissues and of muscles. Thus, the main interest of this concentrate supply could be seen in term of economy when grazing resources were very low. Recent experiments supported by the PRAD programme (PRAD 0011) showed that in comparison with an indoors feeding (common feeding systems based on concentrate in Morocco for meat lamb and goat production), the feeding method based on Argan tree grazing with concentrate or not presents the following advantages in regards of dietetic quality of meat: lower contents in lipids and cholesterol in muscles, an higher proportion of *n*-6 and *n*-3 polyunsaturated fatty acids (PUFA) and a lower *n*-6/*n*-3 PUFA ratio. The low fat content and FA profile of the meat from the goats reared in Argan tree forest results in beneficial characteristics in regards of human health (Wood and Enser, 1997).

Table 2. Fatty acid composition of adipose tissues and of muscles of goats

	Adipose tissues [†]			Muscles		
	ZP	PA	PP	ZP	PA	PP
C _{16:0}	29.0 ^a	24.1 ^b	25.4 ^b	20.3 ^a	19.0 ^b	19.0 ^b
C _{18:0}	33.1 ^a	35.8 ^{ab}	35.0 ^b	14.5 ^a	17.6 ^b	17.9 ^b
C _{18:1n9c}	20.9 ^a	16.1 ^b	14.8 ^b	45.7 ^a	33.4 ^b	32.1 ^b
<i>n</i> -6 PUFA ^{††}	1.5 ^a	2.6 ^b	2.8 ^b	6.0 ^a	10.1 ^b	11.2 ^b
<i>n</i> -3 PUFA ^{†††}	0.07 ^a	0.45 ^b	0.55 ^b	0.8 ^a	3.1 ^b	3.3 ^b

[†]Adipose tissues (average values from omental and perirenal tissues).

^{††}*n*-6 PUFA: polyunsaturated fatty acids of the serie *n*-6, consisted of: C_{18:2n-6}, C_{18:3n-6} and C_{20:4n-6} for the adipose tissues and C_{18:2n6}, C_{18:3n6}, C_{20:2n6}, C_{20:3n6}, C_{20:4n6}, C_{22:4n6}, for the muscles.

^{†††}*n*-3 PUFA: polyunsaturated fatty acids of the serie *n*-3, consisted of: C_{18:3n-3} for the adipose tissues and C_{18:3n-3}, C_{20:3n-3}, C_{20:5n-3}, C_{22:5n-3}, C_{22:6n-3}, for the muscles.

Two values from the same line with a same letter are not significantly different, with 2 different letters are significantly (P<0.05) different.

In addition, finding of the sensory tests (Table 3) indicated that the meat of goats reared in Argan tree forest is appreciated mainly by consumers in this area: this was confirmed by the results of sensory panels during the experiments. But, in Morocco, the frequency of cardio-vascular diseases is progressing quickly. On the other hand, a new tendency Moroccan consumer is aimed at coming back to traditional products.

Table 3. Consumer test on goat meat from young goats reared on 3 different feeding systems

Treatments	No access to Argan	Access to Argan and concentrate	Access to Argan without concentrate
Score [†]	2.6	4.3	4.8

[†]Score from 0 (lowest appraisal) to 5 (highest appraisal).

Typical product

This meat of young goats presents a very marked typicity. Firstly, the animal management in Argan forest recalls consumers of the past traditional rearing methods using the available vegetation specific of the area and opposite to the indoors intensive methods based on feeds produced out of the area where young goats are reared. Secondly, this meat production depends on the aerial grazing of the Argan tree. Consequently, the production area is linked to the presence of Argan trees which

distinguish the South-western region of Morocco between Essaouira and Agadir. All these characteristics make of this kid meat a typical product ("produit du terroir") defined by a region with well defined borders, a typical goat population capable to climb on trees, and a specific feeding based on Argan leaves and nuts. But it is also a biological product favourable to human health because goats consume this specific vegetation.

How to valorise this product

The major problems to be solved are the place of this niche product amongst other competitive meats, the maintenance of this specific goat management, the organization of the production and trade chain ("filière") and the reach of consumers likely to be interested by the dietetic quality and typicity of this product.

The Moroccan consumers are very fond of mutton or lamb meats, less goat meat except in some regions as in Arganeraie. But currently, mutton meat is considered as too rich in fat and little favourable to human health. Probably, it is an opportunity for developing the communication on the dietetic quality of young goat meat by pointing out the effect of limiting the risk of cardio-vascular diseases. Still, we must keep in mind that the advanced experimental results above mentioned, do not evidence whether the dietetic quality observed is correlated with goat species or if it can also be observed on other ruminants, particularly on lambs reared in Arganeraie or equivalent extensive environment.

The target to reach is that the consumers with sufficient income are willing to purchase goat meat raised in the Arganeraie. In Arganeraie, peoples traditionally appreciate goat meat but they have limited income. However, in bigger agglomerations of the Arganeraie such as Essaouira, emerge a new social class with improved enough income that appreciate goat meat and usually accept to go to rural souks (weekly markets in rural areas) to purchase the meat of kids fed with Argan leaves and by-products. Such class of people are concerned with health risks and are proud of traditional products. As far as we are concerned, we think that this new social strata should constitute the target to reach.

We got also to involve groups of goat farmers for the valorisation of such niche product in order to find new opportunities for selling which will surely improving the income of farmers. Any valorisation of the product should consider the adaptation of a common strategy for commercial aspects and by cooperating with the other partners of this filière (production and trade chain) such as slaughterers, butchers, etc. Such task is not easy since goat producers of the Arganeraie are small holders and not accustomed with group efforts as it is the case for sheep producers in other regions of Morocco. We have to take into account the sociological environment of this region, namely the different concerns of small and larger holders (see Table 1).

The decision makers must decide whether the help of ANOC (National Association of Sheep and Goats Breeders) which has not a large experience in goat sector can be efficient or not. This Association can implement one or several goat farmers groups and prepare an agreement pooling all rules of production of young goat meat in the Argan tree forest. Afterwards, an independant institution could be nominated for controlling all farmers concerned are in accordance with these rules so as to deserve a label: carcasses of young goats reared in Arganeraie.

This agreement should be discussed with foresters managing the Argan trees forest and Argan oil producers organizations. Particularly the valorisation of young goat meat should promote the sustainability of Argan forest. On another hand, production of such a meat should interfere with production of Argan oil made from Argan nuts, and particularly should not modify the quality of this oil which is now largely valorised at the export.

This strategy to be set up is new and original in Morocco. It must be well adapted to socio-economic conditions characteristics of vegetation and environment in this region, and to cooking traditions of consumers. Similar proceedings have always been managed in some North European countries, particularly by setting up farmers' groups and an organization supporting a quality product, as to manage together the policy of production, trade and product quality (Dubeuf, 1995). Advisory services can help these organizations (Léger, 2001). In most cases, the diversity of production systems must be accepted to facilitate agreement between producers. An approach for valorising

pastoral areas due to extensive systems of small ruminant meat production can improve the "image" of meat product (Léger, 1999).

Conclusion

This study shows that Mediterranean products have specific and interesting qualities but still need to be better valorised.

We are aware of the efforts which got to be dedicated to the success of the development and valorisation of the production of young goats meats reared in Arganeraie. This success depends on the self-awareness of goat farmers, the commitment of decision makers and the capacity of consumers to be sensitive to product's quality.

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