

DESCRIPTIVE ANALYSIS OF RABBIT MEAT MARKETING PARAMETERS IN THE NORTH-EAST OF ALGERIA

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Abstract: As in many African countries, the rabbit meat sector in Algeria lacks a structured market system. Very few studies have approached this issue. Thus, this paper aims to investigate the main parameters of rabbit meat marketing. To meet this objective, a descriptive survey method was provided, using a structured questionnaire, literature review and direct observation. Our study has covered the key areas of rabbit production including ten *wilayas* (i.e. geopolitical districts, regions, provinces, areas) situated in the north-eastern part of Algeria. A survey was carried out among 32 butchers. Data were obtained through a field survey using face-to-face interviews. The result shows that the butchers are mostly men, belonging to six main *wilayas*; the majority of them are married, with an average age of 45 yr, and most have secondary school level or baccalaureate educational qualifications. Cross tabulations have shown a significant coefficient between location of butchers and four marketing factors i.e. rabbit selling criteria, sales volume per week, type of meat sold, and type of clientele. Hierarchical cluster analysis (HCA) and principal component analysis (PCA) allow us to classify and to show the correlation between the different *wilayas* and the influential marketing factors. Rabbit meat market seems to be modest, fragmented and not organised, due to many obstacles, mainly lack of knowledge and awareness of rabbit meat, high cost production, high selling price and unavailability. Despite these setbacks, there is an opportunity to enhance rabbit marketing by increasing production, supporting breeders, reducing the selling price of rabbit and educating people about the nutritional quality of this kind of meat. To the best of our knowledge, this research is the first to create the sociogeographic profile of rabbit butchers and investigate the association between the different aspects and factors linked to rabbit meat marketing.

Key Words: rabbit meat, butcher sociogeographic profile, marketing factors, Algeria.

INTRODUCTION

Meat consumption has been part of human culture for millennia; in addition, it has historically been driven by the pleasurable experience of eating meat and its high nutritional value (Aboah and Lees, 2020). Rabbit meat appears to be able to satisfy consumers' nutritional needs (Wood *et al.*, 2008) and status as an important resource that may solve part of the food shortage problem around the world (El-Sabrou, 2018). Additionally, this type of meat is preferred as a sustainable source of proteins in an era where climate change, population and changing meat consumption patterns are growing in developing countries (Mutsami and Karl, 2020). Rabbit has a relatively low production cost and high nutritional meat quality, including low fat, sodium and cholesterol levels (Lukefahr, 2010). Other qualities include the

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immense potential and good attributes which include high growth rate, short gestation period and high prolificacy comparable to that of broiler chicken, (Baruwa, 2014). With good husbandry, rabbits can produce over 40 kits per annum compared to one calf for cattle and up to two kids in goats (Dairo *et al.*, 2012). Rabbits are considered odour-free, noiseless, and can adapt to many ecosystems, unlike many of the larger ruminants (Muriithi and Matz, 2015). The rabbit has also the ability to thrive on green forage, food wastes and agricultural by-products, with potential income generation and limited competition with humans for similar food (Ensminger, 1991; Egbo, 2001). Rabbit meat also had a negligible fraction of enteric methane production (2.3%) compared to beef (65.5%), dairy (26.2%) and pork (6.1%). Furthermore, amongst the animals, rabbits have the highest feed conversion efficiency (Vayssieres *et al.*, 2010), which is considered to be a key factor in the prediction of environmental sustainability and economic success (Cesari *et al.*, 2018). Rabbit meat consumption is not popular worldwide. It is thus considered a speciality market, and is mainly limited to the Mediterranean region, namely Italy, Spain, France, Portugal, Egypt, Algeria, Cyprus and Malta, as well as some other European countries such as Germany, Belgium, the Czech Republic and Luxembourg (Dalle Zotte and Cullere, 2019). Based on the international literature, the FAO (2019) reports that in Algeria, rabbit meat production accounted for 0.9% i.e. 8569 ton of the global world production (883 936 ton). Like many developing countries in Africa, Algeria is still in the initial stages of developing a vibrant rabbit sector. Rabbit farming remains a marginal production activity. In rural areas, it still takes the form of individual farms and smallholdings (Merad *et al.*, 2015). In recent years, rabbit breeding in Algeria has been marked by a new relaunch. This development is supported by the various financing mechanisms for the development of rabbit farms set up by the authorities to promote animal production and diversify the supply of animal protein (Mouhous *et al.*, 2020), as well as state aid for the establishment of new rabbit breeders (Mouhous *et al.*, 2019). The global food market is undergoing many transformations. In many developing countries, the rabbit is purposely bred to achieve self-sufficiency in home protein. Unfortunately, rabbit production, introduced as an alternative to remedy the shortage of protein, has not received sufficient attention (Nina *et al.*, 2020). As in Algeria, the rabbit meat production sector is still characterised by a lack of organisation and structure that affects all its segments, feed, breeding and commercialisation (Mouhous *et al.*, 2019).

It is important to remember that meat marketing is the most important part when farming with rabbits, and it is also the most difficult and time-consuming. The issues underlying the marketing strategies include the increasing importance of quality, organoleptic and sensory properties of food in general, as well as issues relating to food safety and human health (Hoffman *et al.*, 2004).

In addition, raising rabbits for meat production must include several considerations, among others availability of processing facilities, market requirements, transportation cost and potential buyers. In the Algerian market, rabbit meat is still rarely found compared to chicken, turkey, sheep and beef. In fact, there is scant knowledge regarding the marketing factors that affect the purchasing of rabbit meat. It should be noted that there are very few studies that have focused on rabbit meat marketing. Much of the existing literature has also analysed subjects in relation to feed and feeding, nutritional requirements and growth (Berchiche *et al.*, 2000; Kadi, 2012; Mouhous *et al.*, 2017, Harouz-Cherifi *et al.*, 2018) or reproduction (Gacem and Lebas, 2000; Zerrouki *et al.*, 2005; Gacem *et al.*, 2009). In this situation, it is worth investigating the attributes and the various intrinsic and extrinsic quality cues of rabbit meat that affect its purchasing and the socio-geographical variables which characterise butchers and butchery activity. So, the overall aim of this research is to determine the main parameters and factors that affect rabbit meat marketing in north-eastern Algeria from the viewpoint of the butchers.

MATERIAL AND METHODS

Scope and information sources

In order to characterise the features of rabbit meat butchery in north-eastern Algeria, searching for butchers to take part in the survey was carried out in varying ways: in the first step we used the literature review, i.e. publications and also local technical reports. The second step revolved around gathering contact details and addresses of butchers from the Technical Institute Of Animal Production, some producer organisations, the trade office and personal contacts.

Study area and sample selection

To meet the objective of this study, the descriptive survey method was used. Data were obtained through a field survey using face-to-face interviews, combined with structured questionnaire. Personal observations during the fieldwork helped us in gathering information about carcass presentation at butcheries and rabbit slaughter, butchering and preparation steps at the slaughterhouse. The survey data were gathered during a period that lasted from October 2016 to March 2017, whereas the data concerning the slaughterhouse were collected in 2020.

Our study has covered the north-eastern regions of Algeria, including ten *wilayas* (Figure 1), also called as governorates or provinces. The study areas are located between latitude 34°44 and 36°59 North and longitude 4°8 and 8°4 East. It covers 48 766 km² with 8.6 million in habitants (Figure 1).

The questionnaire was pretested with ten butchers —one butcher from each region— in order to gather first-hand information about rabbit meat marketing in the study areas. Relevant changes were then made to the questionnaire based on these findings, which helped validate our questionnaire. The simple random sampling method was used to select the targeted respondents at different location such as shopping malls, daily markets and butchers' shops. All the butchers found were contacted and invited to participate in the study voluntarily. The sample used consisted of 32 butchers. Data were obtained through a field survey using face-to-face interviews. This required only a few minutes to be completed by the participants who were willing to take part in the survey. A dual-language structured questionnaire was developed in Arabic and French to make it easier for the participants to understand and provide responses.

The survey form was divided into two sections and included 19 questions (questionnaire) which are explained by closed questions with multiple choice and open-ended questions that allow the butchers to choose a specific answer or give their opinion freely. The data obtained from the questionnaire were organised by coding the questions to prepare them for data collection.

The questionnaire introduced questions to gather information regarding butchers' socio-geographical characteristics such as age, marital status, educational level, seniority, geographical location and general information concerning marketing policy, such as the type of meat sold, supply, rabbit selling criteria (age and weight of slaughter, slaughter yield, price, etc.), purchasing format, sales volume per week, etc. In addition to this, the trade circuit, marketing obstacles and proposed solutions were discussed.

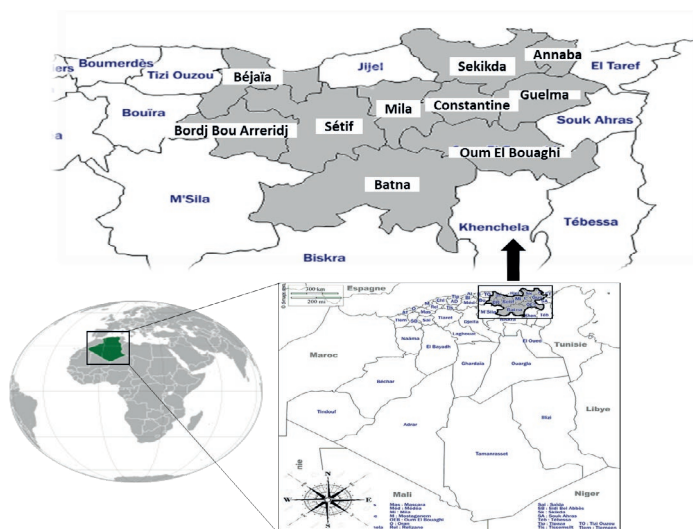


Figure 1: Geographical map showing the distribution of the *wilayas* surveyed (the study area).

Conceptual framework

In our study the conceptual framework is provided using dependent variables and independent variables, as well as their relationship, as illustrated in Figure 2. Examples of this methodology can be found in (Hoffman *et al.*, 2004; Kadi *et al.*, 2013; Baviera-Puig *et al.*, 2017; Benabdelaziz *et al.*, 2020).

Statistical analysis

Depending on the target, a different statistical analysis was used. First, a Chi-square (χ^2) test was used to find the relationship between dependent and independent variables using XLSTAT 5.03. Version 2014. Second, in order to classify the different *wilayas* and establish the correlation between geographical location areas and rabbit marketing factors. Hierarchical cluster analysis (HCA) (HAC using the Ward method) followed by principal component analysis (PCA) were carried out. HCA and PCA were performed using the statistical software JMP Trial 15 (SAS Institute Inc. Cary, NC, USA). A *p*-value less than 0.05 was considered statistically significant.

RESULTS AND DISCUSSION

Sociogeographic profile of butchers

The butchers' sociogeographic data are given in Table 1. The survey revealed that our participants are mostly men, and 62.5% were married. The average age of the surveyed participants was 45.25 yr. The majority of the participants (24) belonged to the 40-59 yr old age group and accounted for 75% of total responses, whereas participants between 18-39 yr of age (7) accounted for 21.87% of responses. Only 3.12% were older than 60. In terms of educational level, a large percentage (53.12%) of participants had secondary school level or baccalaureate, 34.37% were educated at primary school or vocational training school, while 6.25% had postgraduate degrees, and only 6.25% of the sample had no studies. Most of the participants (71.87%) were not new to butchery activity (more than 5 yr of experience). As for the geographic distribution, the majority of butchers' shops (27; 84.36%) were located in six main *wilayas*: Bordj Bou Arreridj, Sétif, Mila, Constantine, Batna, and Béjaïa. These are the main areas where rabbit breeding units are present (Sanah *et al.*, 2020); the remaining *wilayas* such as Sekikda, Oum El Bouaghi, Guelma and Annaba presented a low number of butchery shops (5; 15.64%).

Our survey revealed that butchers selling rabbit meat are mainly located in urban areas, specifically in poultry shops. Those shops are generally located in municipal markets and malls. This observation agrees with those of Kadi *et al.* (2013) and Mezali *et al.* (2014), who conducted similar studies in other regions of Algeria. The results show that the

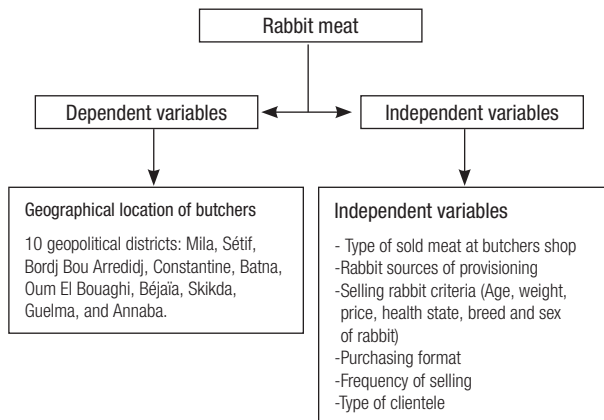


Figure 2: Conceptual framework of the study, depicting the independent and dependent variables.

marketing of rabbit meat takes place in very specific butchers located in the metropolitan and municipal markets and malls. Therefore, urban citizens who like rabbit meat can buy it only in a few stores at the level of the urban centre, often several kilometres away from their place of residence (Kadi *et al.*, 2008).

Relation between rabbit meat marketing factors and geographical location

Cross tabulations for rabbit meat marketing factors (dependent variables) according to sociogeographic characteristics of butchers (independent variables) have shown statistically significant coefficients between geographical location of butchers and some marketing factors (Table 2). Chi-square test confirms that geographical location (district) has a significant association with four dependent variables: type of meat sold ($\chi^2=54.49$; $P=0.001$), rabbit selling criteria ($\chi^2=83.71$; $P=0.000$), sales volume per week ($\chi^2= 64.00$; $P<0.0001$) and type of clientele ($\chi^2=46.31$; $P=0.012$). In contrast, geographical area is invariant to the remaining factors such as rabbit sources of provisioning and purchasing format.

Type of meat sold

When asking butchers about the type of meat sold in their shops, more than 65% of them are poultry shops, i.e. they specialise in selling chicken and turkey meat. Meanwhile, in the rest of butchers we have observed other types of meat, basically sheep, beef or rarely goat meat. Chi-square test confirms that the type of meat sold in these shops has a significant association with geographical location of the butchers ($\chi^2=54.49$; $P=0.001$), which can be explained on one hand by the fact that rabbit meat is considered among white meats. On the other hand, the diet in Algeria generally consists of poultry, eggs, sheep and beef, whereas the consumption of goat and camel meat is much lower and each region is characterised by one or two major types of animal (livestock) production (Sadoud, 2011; Chikhi and Bencharif, 2016).

Rabbit selling criteria

Regarding the question: *What are the purchasing criteria for rabbit that you require?* The results showed that the main attributes that butchers consider when purchasing rabbit are as follows: age (41%), weight (15%), selling price (15%), health state (15%), breed (9%) and sex of the rabbit (3%).

Age and weight of the rabbit for sale. Our survey revealed that the selling weight is around 1.5 to 3 kg, and the age at slaughter is 10 to 14 wk, with slaughter yield around 65%. These results are very close to those observed in other geographical regions. In a recent paper by Benabdelaziz *et al.* (2020), the selling weight observed in Algiers region was around 2.45 kg. In another recent paper published by Dalle Zotte and Cullere (2019), the authors pointed out that rabbits farmed for meat purposes in intensive systems are specialised hybrids slaughtered at 11 to 13 wk of age, and, therefore, characterised by uniformity in carcass traits. In Western Cap, Hoffman

Table 1: Socio-geographic profile of butchers (n=32).

Variable	Frequency	%
Total respondents	32	100
Gender		
Male	32	100
Female	0	0
Age (yr)		
18–29	4	12.5
30–39	3	9.37
40–49	12	37.5
50–59	12	37.5
>60	1	3.12
Marital status		
Single	12	37.5
Married	20	62.5
Educational level		
No studies	2	6.25
Primary school	4	12.5
Vocational training school	7	21.87
Secondary school	6	18.75
Bachelor	11	34.37
Other (Master, doctorate,...)	2	6.25
Seniority (yr)		
1-5	9	28.12
>5	23	71.87
Wilaya (districts)		
Bordj Bou Arreridj	6	18.75
Sétif	6	18.75
Mila	5	15.62
Constantine	4	12.5
Batna	3	9.37
Béjaïa	3	9.37
Sekikda	2	6.25
Oum El Bouaghi	1	3.12
Guelma	1	3.12
Annaba	1	3.12

Table 2: Cross tabulations of rabbit meat marketing factors according to socio-geographic characteristics of butchers.

Dependant Variables	Selling rabbit criteria						Frequency of selling			χ^2	P-value		
	We	Ag	Pr	He	Br	Se	<20 car/wk	20-60 car/wk	>60 car/wk				
BBA	1	1	1	2	0	0	83,7	<0,0001	0	5	0	64	<0,0001
Sétif	0	0	4	0	0	0			0	0	4		
Mila	3	0	0	0	0	0			0	3	0		
Cne	6	0	0	0	0	0			0	0	6		
Batna	0	3	0	1	1	1			0	0	6		
Béjaïa	2	1	0	0	0	0			0	0	3		
Sekikda	0	0	0	0	2	0			0	2	0		
OB	0	0	0	1	0	0			0	1	0		
Guelma	1	0	0	0	0	0			1	0	0		
Annaba	0	0	0	1	0	0			1	0	0		
Total	13	5	5	5	3	1			2	11	19		
%	40	16	16	16	9	3			6	34	60		

Dependant Variables	Type of meat sold							Type of clients				χ^2	P-value
	Ch & Tu	Sh	Be	Goat		χ^2	P-value	Ho	Ho+ht+Re	P.I	Ba		
BBA	3	2	0	0	54,49	0,001	0	2	0	0	46,31	0,012	
Sétif	4	0	0	0			2	2	0	2			
Mila	3	0	0	0			0	3	3	0			
Cne	6	0	0	0			6	0	0	0			
Batna	0	0	5	1			3	1	0	0			
Béjaïa	3	0	0	0			0	3	0	0			
Sekikda	0	2	0	0			1	1	0	0			
OB	0	1	0	0			1	0	0	0			
Guelma	1	0	0	0			0	1	0	0			
Annaba	1	0	0	0			1	0	0	0			
Total	21	5	5	1			14	13	3	2			
%	65	16	16	3			44	41	9	6			

BBA: Bordj Bou Arreridj; Cne: Constantine; OB: Oum el Bouaghi; W:Weight; A:Age; P: Price; Br:Breed; Sex: Se; car/wk:carcass/week; Ch & Tu: Chiken & turkey; Sh: Sheep; Be: Beef; Go: Goat; Ho: Households; Ho+Ht+Re: Households+hotels+restaurants; P.I: private individuals; Ba: Bars.

et al. (2004) argue that a commercial producer should consider table rabbits that are likely to weigh 2 kg at an age of 9 to 10 wk, and which will produce the greatest amount of profit. According to the Australian market demand, a previous study reported by Eady and Prayaga (2000) stated that rabbits sold as a whole carcass in butcher shops are slaughtered at 1.0 to 1.3 kg, while those portioned for the restaurant trade are slaughtered at 1.4 to 1.7 kg. These authors added that the differences in slaughter weight are associated with differences in growth period on the farm.

In Spain, the average rabbit live weight at slaughter in 2012 was 2.190 kg (Pascual *et al.*, 2014). Meanwhile, in France and Italy, the rabbit live weight at slaughter is 2.5 to 2.6 kg (Xiccato and Trocino, 2007; Coutelet and Hurand, 2016). In the same context, Dalle Zotte (2014) stated that slaughter age, which typically ranges between 9 and 13 wk and a slaughter weight from 2.0 to more than 2.6 kg, is dependent on market requirements. Similar observations were made by Moreki *et al.* (2019) in their survey in Botswana with rabbit breeders, as they found that rabbits were sold from six weeks of age. Moreover, forty-five percent (45%) of the respondents said they used age and weight to set prices for their rabbits, followed by 25% who used a combination of age, sex and weight, and 10% who used age only. Heavy rabbits fetched a better price than lighter rabbits.

Selling price of rabbit meat. As regards the selling price of rabbit meat, it varies between 700 and 900 AD/kg, (4.35 and 5.59 €/kg) (1 Euro=160.98 AD). The live rabbit is sold at between 300 and 400 AD (1.86 and 2.48 €/

kg). In previous studies, Mezali *et al.* (2014) found an average price around 750 AD/kg for a purchasing price varying between 400 and 500 AD/kg. This result is also confirmed by Merad *et al.* (2015).

In a recent paper by Benabdelaziz *et al.* (2020) the living rabbit is sold for a price that varies between 360 and 400 AD/kg (2.70 and 3.00 €/kg) for wholesale and between 500 and 550 AD/kg (3.75€ and 4.12 €/kg) for retail, whereas the slaughtered rabbit is sold at a price that varies between 650 and 800 AD/kg (4.87€ and 6.00 €/kg). It was found that the price of one kilogram of rabbit meat is more expensive for sale than that one of white meat i.e. poultry 298 AD (2.23€/kg), and turkey 405 AD (2.51 €/kg), but lower than that of red meat i.e. beef 1251 AD (7.77 €/kg), and sheep 1486 AD/kg (9.23 €/kg) (Benabdelaziz *et al.*, 2020).

It appears that the price of rabbit meat varies in each country, but can cost between 4-8 €. For example, in Greece, the price of 1 kg of rabbit meat is 8 € (Spilioti *et al.*, 2017). Another recent study in Vietnam, by Thu (2019) found that the price of meat rabbit sold to intermediaries has recently been varied, from 2.3 to 2.75 USD/kg live weight; however, it has been around 7.0 USD/kg carcass weight when sold to the consumers. The price of reproductive rabbits has been much higher and depends on the breed quality. In Abidjan, the price of a kilogram of live rabbit is 3000 to 5000 CFA franc (US\$ 5.05 to 8.42) for Ivorian producers. However, the price of one 1 kg of live rabbit is more expensive in Côte d'Ivoire than in Senegal (2500 to 3000 CFA franc/kg or US\$4.21 to 5.05) (Nina *et al.*, 2020).

It should be noted that in Algeria, the price of one kg of this meat in butchers increases over the years. According to Kadi *et al.* (2013), the price increased considerably because of the increase in the price of the raw materials on the world market and which constitute the feed of the rabbits, as many of their main ingredients such as soybean meal, dehydrated alfalfa, corn and other micro ingredients are imported from overseas.

Similar observations were made by Pascual *et al.* (2014) where the variation in prices of raw materials for manufacturing feed in recent years has been one of the most influential factors in the accounting results of rabbit farms and one of the main causes of their lack of profitability, as no notable increase in earnings for rabbit producers has been reported. These raw materials are mainly of European origin, but despite this, their prices have been affected by swings in feed costs in general (CESFAC, 2012).

Breed, health state and rabbit sex. As noted in the interviews, type of breed, health state and rabbit sex seem to be less important criteria when selling rabbit. The most common breeds observed in this study are synthetic rabbit line (ITELV 2006) which has been reared in Algeria since 2003, New Zealand White and Californian rabbit; these last two breeds have also been reported to be the most popular breeds for meat production in other parts of the world due to their good growth characteristics and a high meat: bone ratio (Serem *et al.*, 2013). In Spain, Baviera-Puig *et al.* (2017) had also observed similar trends where rabbits raised for meat are generally the New Zealand White breed. This observation is also made by Iheukwumere *et al.* (2018) in Nigeria, where the two most popular breeds reared are New Zealand and the Californian.

Based on the analysis presented earlier, it appears that rabbit selling criteria such as age, weight, and selling price of rabbit are almost the same among European and African countries.

Purchasing format of rabbit and main selling sources of provisioning

Most of the butchers interviewed (75% of them) buy their rabbits either alive or slaughtered directly from the farmers (at farm level), while 25% of butchers buy their rabbits from local markets.

It should be noted that the butchers who buy their animals alive usually set aside a place around the butcher shop to sacrifice their rabbits without any veterinarian inspection, as there were no slaughterhouses specialised in rabbit. This observation agrees with those of Benabdelaziz *et al.* (2020), who conducted a similar study in Tizi-Ouzou area (Algeria). They found that the slaughtering at farm level is carried out without any sanitary control by an approved veterinarian, and that farmers use these practices to increase their profits.

In the same context, our results are in agreement also with those of Kadi *et al.* (2013), who found in Tizi-Ouzou that rabbits are marketed live or killed to butcheries, poultrys and restaurants. They are bought from producers generally as whole carcasses in 86.49% of cases.

Similarly, in Benin, it was also found that rabbits are marketed either alive (31% of cases) or in the form of a carcass (69% of cases) (FAO, 2018). In Botswana, rabbits were sold alive or dressed. As there are no rabbit slaughter facilities in this country, rabbits were slaughtered and dressed in home kitchens prior to delivery to retailers, hotels and individual buyers (Moreki *et al.*, 2019). Our findings are also similar to those in a previous study conducted by Bodnár (2009) in Hungary, who reported that clients bought live rabbits, whole carcasses or different rabbit meat cuts.

In the present study, rabbits are marketed in butcheries generally as whole carcasses. Whole carcasses include the head, thoracic content (heart, lungs, ...), liver, kidneys and extremities of the legs and the corresponding skin. The offal is discarded (Figure 3).

Algerian legislation relating to the presentation and marketing of fresh rabbit carcass requires that carcasses must be completely dressed except for the head, ears and the hind leg tips; the carcass must be completely eviscerated and the finished product must be packaged and labelled (Benabdelaziz *et al.*, 2020). For an average carcass weight that varies between 0.9 and 1.9 kg. This carcass weight is similar to that reported in several studies carried out in Algeria (Guermah *et al.*, 2011; Kadi *et al.*, 2013, 2016; Hannach-Rabia *et al.*, 2017; Harouz-Cherifi *et al.*, 2018; Benabdelaziz *et al.*, 2020). Our results are similar to those obtained by FAO (2018) in Benin, where they found that the weight of a rabbit carcass varies between 1 and 1.4 kg and the live rabbit weighs on average 2 kg.

Sales volume per week

Sales volume of rabbit meat per week differs significantly according the region ($\chi^2= 64.00$; $P<0.0001$) (Table 2). Generally, between 20 to 200 carcass per week are sold, with an average amount of 63 carcasses. Sétif, Bordj Bou Arreridj, Béjaïa, and Constantine are *wilayas* which present high numbers of sold carcass with more than 60 carcasses per week, whereas Batna, Mila, Oum El Bouaghi, and Skikda represent 20 to 60 carcasses per week. The remaining regions, such as Guelma, and Annaba present less than 20 carcasses per week. Our results are higher than those obtained by Kadi *et al.* (2008) in their survey in Tizi-Ouzou, where they found that the total quantities sold amount to 44.56 kg per week or an average of 32 carcasses per week.

In our study, differences in sale volumes of rabbit meat per week are probably due to a variety of reasons, such as culinary traditions or eating habits of consumers in each *wilaya*; the availability of rabbit meat in local markets, which is related to the number of breeding units and farmers established in each *wilaya*. Moreover, we have observed that sales frequency is related to higher income groups of consumers who are generally found in large *wilayas* like Sétif, Bordj Bou Arreridj, Béjaïa and Constantine.

Rabbit meat customers

Our results show that the type of rabbit meat customers varied significantly with the geographical areas ($\chi^2=46.31$; $P=0.012$) (Table 2). The buyers of rabbit meat are householders (43.75%), restaurant managers with householders and luxury hotels (40.62%), private individuals (9.38%) and bars (6.25%). Our findings coincide with those obtained



Figure 3: Rabbit purchasing format in the chicken store. (A) in Constantine; (B) in Algiers area (B) (Algeria); (C) rabbit cooked format in the restaurant.

by Mezali *et al.* (2014) in their sociocultural and economic research conducted with sellers and consumers of rabbit meat in the region of Algiers (capital of Algeria). They found that the householders are the main buyers of rabbit meat (90% of cases). In Benin, a study by the Food and Agriculture Organization of the United Nations (FAO, 2018) showed that rabbit meat buyers consist mainly of restaurants (79% of cases), individuals and/or households (82% of cases), and traders (39% of cases). A similar result was obtained in a recent study in Botswana, where 46% of the respondents said their clients were restaurants, hotels and supermarkets, individuals (39%) and government institutions (5%) such as schools (Moreki *et al.*, 2019). Another recent research work by Nina *et al.* (2020) in Côte d'Ivoire found that the main customers for rabbit meat are restaurant managers (35%) and households (35%), while supermarkets and ranchers are the other customers, with 15% each.

Hierarchical cluster analysis (HCA) and principal component analysis (PCA)

In order to identify and classify the study area i.e. 10 geopolitical districts (*wilayas*) which share the same marketing factors, a constellation diagram was drawn up. This diagram (Figure 4) consisted of three clusters. Cluster one (C1) included only one *wilaya*: Sétif. Cluster (C2) contained three *wilayas*: Bordj Bou Arreridj (BBA), Constantine (Cne) and Béjaïa. Cluster (C3) contained the highest number of similar *wilayas*, which are: Mila, Batna, Sekikda, Guelma, Oum el Bouaghi and Annaba. It is clear that the *wilayas* that belong in the same cluster have some similarities. Therefore, the principal component analysis (PCA) was carried out to show the correlation between rabbit meat marketing factors and geographical location of butchers. The first two PCA axes described 71.8% of the total variation. The first axis explained that 41.9% of the variance was strongly correlated with the following factors: selling rabbit criteria especially (weight, age and selling price), type of meat sold and type of clientele. The second axis explained 29.9% of the variability that is mainly represented by one factor i.e. frequency of selling. It clearly shows that each cluster regrouped one or many *wilayas* which have similarities concerning the rabbit marketing factors, for instance: cluster (C2) includes three *wilayas*: Cne, BBA, and Béjaïa, which have a high selling frequency. Sétif district is associated with the type of meat sold, it was observed that in this *wilaya* the rabbit meat is sold along with beef and goat meat. The remaining neighbouring *wilayas* share two main factors: rabbit selling criteria and type of clientele.

Rabbit slaughterhouse and processing

The slaughterhouse represents the processing industry, as it takes in live animals and, after slaughter and butchering, leaves them ready for consumption in several different types of presentation. Slaughterhouses usually integrate the cutting rooms and preparation of the various packaging or presentation options (Baviera-Puig *et al.*, 2017).

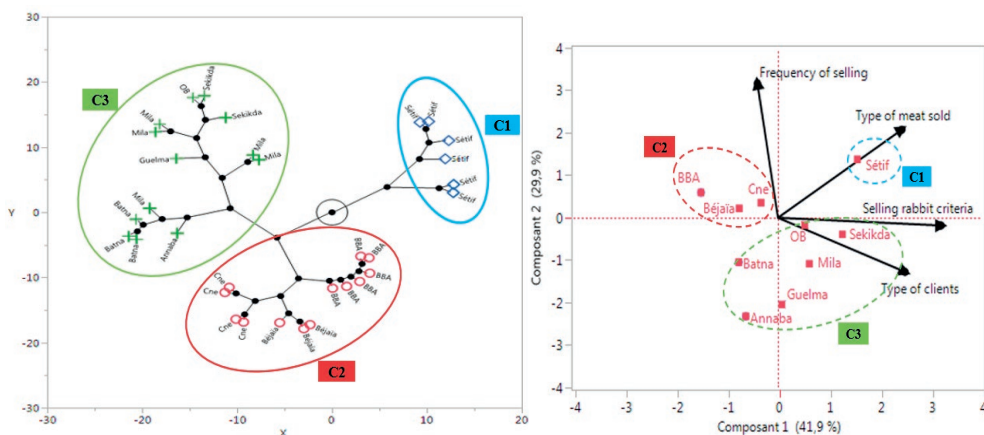


Figure 4: Hierarchical cluster analysis (HCA) and principal component analysis (PCA) between geographical location of butchers and rabbit meat marketing factors. C1 :Cluster 1 ; C2 :Cluster 2 ; C3 :Cluster 3 ; Cne : Constantine; BBA : Bordj Bou Arreridj; OB : Oum el Bouaghi.

Unlike in other types of livestock such as cattle, sheep, turkey or poultry, in the eastern part of Algeria there was no slaughterhouse specialised for rabbits. In the course of our research we had the chance to visit the first slaughterhouse in Algeria specialised in rabbit slaughtering implanted in 2020, located in the industrial area of Bekira, about 3 km from Constantine (*Wilaya* of Algeria). *Cirta abattoir* is a small, modern well-equipped rabbit slaughterhouse which was constructed by Boumali brothers with a capacity of 200 rabbits/d (about 5 Qx per day). The main aim of the slaughterhouse is to increase rabbit meat production, ensuring veterinary control and traceability of production and consumption, in order to finally obtain a packaged and labelled meat product. With collection of the living animals from the different farms, the slaughterhouse sacrifice process takes place on the same day the rabbits are collected from their place of origin. The rabbits are slaughtered by cutting the jugular vein with a sharp knife; the rabbit is held firmly by the rear legs and head and is stretched full length. Logically, by law the slaughterhouse is systematically monitored by veterinary inspectors, as are the qualitative requirements. Based primarily on visual meat inspections, these checks determine aspects such as abnormal odours and colours, malformations, presence of traumatic injuries, bruising and any other serious anomaly or emaciation whose presence qualifies the affected item as unfit for sale (Baviera-Puig *et al.*, 2017). According to slaughterhouse managers, handling of the meat is done under strict security and hygiene measures to ensure products with the maximum quality and freshness. Before packaging, the carcasses are cleaned to remove hair and any soil or debris. In the final packaging zone, the required weight of the carcasses will be controlled depending on each client, always between 1-1.2 kg. Dressed rabbits may be sold as whole carcass, half carcass or quartered and cut into pieces, then bagged or tray-packaged with their own brand.

Finally, the rabbit carcasses are stored at a cold temperature, preferably at 4°C, before delivery and are distributed to different consumers in refrigerated trucks. The slaughterhouse distributes the rabbit meat especially to butchers and private individuals at a price of 800 DA per kg (Figure 5). As noted in the interviews, the managers use different methods to market their products and these are through social media (Facebook), breeders' association, participation in national and local fairs and exhibitions. It should be noted that the whole carcass with high weight is more attractive for Algerian consumers according to the experts interviewed. In contrast, a different situation is present among Greek consumers. The sale of rabbit meat as a whole carcass and not in pieces of meat, did not appeal much to consumers, as its cooking method is complex and time-consuming. Young consumers prefer eating food that requires only a short preparation time (Spilioti *et al.*, 2017). The first steps in modern processing are slaughtering, evisceration and



Figure 5: Slaughter and processing steps at rabbit slaughterhouse in Constantine areas (Algeria). (A): Collect of alive animals; (B): Rabbit slaughter; (C): Rabbit skinning and evisceration; (D): Rabbit carcass sweating ; (E): Whole carcass packaging; (F): Cut-up parts carcass packaging ;(G): Marketing of packaged and labeled meat in the butcher shop.

chilling of carcasses (Cavani and Petracci, 2004). Further processing can be referred to as the operations ranging from cutting of the carcass into parts, packaging of raw consumer products, deboning and portioning to formulation of specific products (shaping, marinating, coating, etc.), cooking and packaging (Petracci and Cavani, 2013). It should be remembered that processed rabbit meat products (deboned, marinated, cooked, etc.) are still non-existent in the Algerian markets compared to other types of meat like chicken, sheep or beef. This is in agreement with the results of a recent study by Moumen *et al.* (2016) in the Aures region (Algeria). They found that rabbit meat is consumed at home without processing, and the final quality of the product mainly depends on the raw material, i.e. the chemical composition of the muscle. In this regard, many studies have found a similar situation. Cavani *et al.* (2009) in their paper reported that the majority of rabbit meat is sold as whole carcass and cut-up, strictly remaining a commodity in which almost all consumption is based on home preparation. In contrast, the market share of processed poultry meat products has seen a tremendous increase in recent decades. Our results are also similar to those obtained by Petracci and Cavani (2013), which reported that rabbit meat is still currently sold worldwide as whole carcass or at least as cut-up parts, while very low quantities are marketed as processed products (i.e. ready-to-cook, ready-to-eat meals, etc.). Falahudin *et al.* (2020) also confirmed that processed meat products of rabbit meat are still rarely found in the market compared to chicken or beef. In Spain, similar observations were made by Baviera-Puig *et al.* (2017), where the sales by presentation type are usually around 80% in carcass and 20% quartered, as reported by different respondent wholesalers and slaughterhouse managers.

It should also be noted that, in Algeria and for the first time, two breeders' associations, nationally and locally, were created between 2018 and 2019. Thus, many rabbit breeders wanted to structure themselves in an organisation to develop this sector and benefit from government facilitations. As recommended by Benabdelaziz *et al.* (2020), rabbit farmers should form active and efficient associations and cooperatives in order to allow a better structure and organisation of the sector for the eradication of the constraints.

Rabbit meat marketing circuit

Commercial distribution represents the last link in the rabbit meat value chain, before reaching the final consumer (Sabora, 2009). In Eastern Algeria, the upstream of cuniculture sector is made up of breeders and resellers, whereas the downstream consists of butchers and consumers.

The breeders who constitute the first link in the rabbit commercial chain sell their rabbits to four types of buyers, namely consumers, butchers, resellers and recently to the slaughterhouse. Rabbits distribution follows the following different channels (Figure 6):

- Channel 1. Consumers, the last link in the chain, will buy rabbits (alive or slaughtered) directly from the breeder (the farm). This is found to be the most common method for 56% of consumers (Sanah *et al.*,2020).
- Channel 2. The consumer (14% of them) can also buy rabbit from the butcher (Sanah *et al.*,2020).
- Channel 3. The butcher will source rabbits from resellers (markets), with the aim of selling it to the consumer.
- Channel 4. Resellers or intermediaries come to get their supplies of live rabbits from breeders in order to sell them at a higher price in commercial areas (markets, butchers).
- Channel 5. Recently, some consumers prefer to buy rabbits directly from the slaughterhouse.
- Channel 6. Finally, the breeders can buy rabbits from resellers (a two-way distribution) in order to renew their livestock.

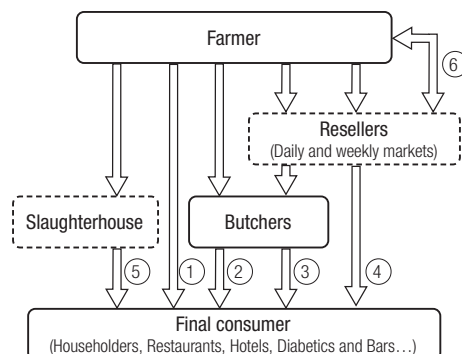


Figure 6: Proposal diagram of rabbit meat marketing channels in eastern part of Algeria.

Similarly, in Tunisia a survey carried out by Besbes *et al.* (2003) showed that the distribution system of rabbit is

dominated by the sale of live rabbits (73%) via multiple trade channels, such as municipal markets and specific points of rabbit sales in conglomerations, as well as in the weekly markets.

This proposed diagram of rabbit meat marketing channels can provide an overview of the sector and enables us to understand the relations between its components and its positioning towards the final consumer. Knowledge of this mechanism is therefore a deciding factor when it comes to understanding the manner in which rabbit meat reaches the end consumer (Baviera-Puig *et al.*, 2017).

Rabbit sector obstacles

Participants were asked to express their opinions about the marketing situation of rabbit meat. The rate of sale of rabbit meat is estimated to be fair according to most of the butchers questioned (44%). However, 37% of them said that it is good, and the remaining butchers considered it bad (19%). It should be noted that in Algeria, rabbit meat consumption is related to certain periods of the year or events. Thus, rabbit meat consumption peaks are mostly in winter and during the month of Ramadhan. Nevertheless, periods of low consumption are the religious festivals such as Aid El Fitre, the year-end holidays (Sanah *et al.*, 2020).

Participants were asked to rate the main obstacles that hinder rabbit meat marketing; the results obtained are illustrated in Figure 7. The lack of knowledge and awareness of rabbit meat was highlighted and expressed by the majority of interviewees, followed by high cost production, high selling price, and finally the scarcity of rabbit meat in the market.

Our results agree with several studies in Algeria and in other regions around the world. A previous survey conducted by Kadi *et al.* (2008) in Tizi-Ouzou with the consumers has shown two main obstacles: the lack of demand (75.44% of respondents) and its unavailability (10.78%). Indeed, the lack of consumer acceptance of the product has little impact upon the market because rabbit production has not saturated the market. Current demand for rabbit meat exceeds supply, so consumer acceptance is not a problem. The same study also indicated that the marketing for rabbit meat in this region stays neglected. The marketing is fragmented and inefficient, so the distribution chain of this meat is disorganised. This inefficient marketing system has resulted in higher costs and low availability of rabbit meat with a possibility for expansion through appropriate promotion.

In Algiers region, the investigation of Mezali *et al.* (2014) highlighted the complexity and bad organisation of the rabbit network in Algeria. The results revealed a weak marketing and consumption of rabbit meat, due particularly to its production status remaining mainly traditional, which makes the product unavailable at the retail level.

Another recent research paper in Tizi-Ouzou area (Algeria) made by Benabdelaziz *et al.* (2020) has shown that the obstacles to rabbit meat marketing include the lack of stable markets, the absence of a fluid distribution network, the lack of transparency of transactions and price setting, expensive delivery costs and late payments.

In Georgia, Wolfe *et al.* (2002) reported that the retail rabbit meat market (supermarkets and grocery stores) is underdeveloped and as a result, consumers are unaware of the health benefits associated with eating this low-fat meat and are unaware that supermarkets carry these products.

In Kenya, Borter and Mwanza (2011) observed that rabbit production is not structured, resulting in farmers not able to ascertain the number of rabbits they can make available to the market at any given time. The authors also reported

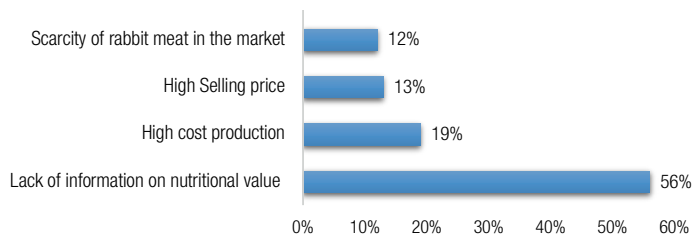


Figure 7: Obstacles hindering rabbit meat marketing according to butchers' point of view (n=32).

that the market is not clearly defined, as many people do not know that rabbit meat can adequately replace other protein sources.

In Botswana, Moreki *et al.* (2019) have cited four major challenges, namely the unreliable market, limited technical information, the lack of government support and high feed expenses.

In Abidjan, (Côte d'Ivoire). The results obtained by Nina *et al.* (2020) revealed the main reasons for non-consumption of rabbit meat, which are unavailability (49%), absence in eating habits (22%) and high cost (20%). In Majalengka area (Indonesia), Falahudin *et al.* (2020) argue that the lack of information about the benefits of rabbit meat is one of the reasons people do not consume it.

Proposal solutions for enhancing rabbit meat marketability

Concerning the question related to the proposal solutions for enhancing rabbit meat marketability, from the point of view of butchers, the answers were varied: 53% of them said that raising public awareness about the health benefits of rabbit meat is necessary, whereas 28% of them focused on supporting rabbit farming, and finally, 19% of respondents proposed increasing production vs. price decreasing (19%). These suggestions confirm those of previous studies in other geographical contexts. To illustrate, in Algeria Kadi *et al.* (2008) noted that the ultimate aim is to educate the public about the high nutritional quality of rabbit meat. More attention must be given to the market outlets and promotions of rabbit meat in the Tizi-Ouzou area.

Mezali *et al.* (2014) reported that to increase rabbit meat consumption, many actions must be undertaken, for instance encouraging rational breeding (genetic improvement, control of reproduction and feeding), production organised in professional groups and restructuring of distribution channels. Benabdelaziz *et al.* (2020) indicated that the current marketing system based on individual initiatives of rabbit farmers cannot, under any circumstances, allow the evolution and development of this sector. It is necessary to opt for a common strategy, developed by advertising and communication professionals. He added that a national promotional campaign is needed to promote rabbit meat and encourage its consumption; this will increase demand and enhance the product's marketability.

Similar suggestions were made in Georgia by Wolfe *et al.* (2002), reporting that the first step towards creating a successful retail rabbit meat market will be informing and educating consumers about the health benefits of eating rabbit, as well as increasing consumer awareness about product availability. Additionally, creating a successful brand. In South Africa, Hoffman *et al.* (2005) pointed out that in order to increase a demand for rabbit meat, an effort is needed to educate people regarding the benefits of rabbit meat. This can be achieved by planning a long-term consumer education campaign to familiarise people with the various aspects and multiple benefits of rabbit meat.

Leroy and Petracci (2021) confirmed that rabbit meat consumption can only be boosted by introducing rabbit meat as an ingredient in processed food products (i.e. ready meals, ready-to-cook, etc.). Otherwise, consumption is bound to become even more marginal, even in major rabbit meat consuming countries. In Abidjan, (Ivory Coast), Nina *et al.* (2020) noted that commercial rabbit operations may be encouraged. Indeed, a more sophisticated market infrastructure may involve product diversification such as tanned skins and processed meat forms, as well as entrepreneurial training, promotion in mass media, competitive pricing and market diversification. By adopting such a logistical development approach, a greater assurance of the sustainable increase of rabbit meat can be achieved.

CONCLUSION

Based on the results of this study, a number of important points are revealed. Butchers in the North-East of Algeria are men, generally married with an average age of 45 yr. The majority of them had secondary school level or baccalaureate. Mostly, they were not new to butchery activity. The majority of butchers' shops are located at the main urban areas where rabbit breeding units are present. Our results have also shown a significant statistical coefficient between geographical location of butchers and some marketing factors, such as type of meat sold, rabbit selling criteria, sales volume per week and type of clientele.

As in many developing countries, rabbit marketing in Algeria is still modest, not organised or structured. It is practiced on a small scale in all the *wilayas* surveyed. Rabbit meat is still currently sold as whole carcass. The lack of knowledge

and awareness of rabbit meat, high cost production, high selling price, and unavailability of rabbit meat are the most factors that limit rabbit meat marketing.

In order to develop rabbit trade in Algerian markets, increasing production is the first step; this can be achieved by encouraging genetic improvement, improving farming strategies and developing feeding resources. It is also essential to increase good government policies by supporting the breeders, improved research results, setting clear veterinary procedures in processing of rabbits in order to enhance the chain, as well as restructuring of distribution channels, and mainly reducing the selling price of rabbit. It is therefore advisable to educate people regarding the benefits of rabbit meat, focusing on its nutritional attributes by using mass media and the national rabbit breeders' associations.

Finally, it should be emphasised that the new slaughterhouse can play an important role in enhancing rabbit meat commercialisation by offering a healthy, packaged and labelled product with different cut-up parts possibilities. Subsequently, it can develop innovative products such as smoked and marinated meat. This may encourage the Algerian consumers to include rabbit meat more in their recipes.

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QUESTIONNAIRE

Date of survey:...../...../.....

Questionnaire N°.....

Butchers' socio-geographical profile

- Butcher's address (Wilaya /municipalitie):
- Sex : Male Female
- Age :..... Year
- Marital status : Married Single
- Educational level: No studies Primary school Vocational training school
Secondary school Bachelor Other (Master, doctorate,...)
- Seniority : 1-5 yr > 5 yr (How long have you been established ?)

General information on supply, rabbit slaughter

1/What are the other types of meat sold in your shop?

Beef Sheep Goat Turkey Chicken

2/ Where do you currently buy rabbit from ?

Farms (breeders) Local markets

3/ What are the purchasing criteria for rabbit, which you require ?

Weight Price Sex Age Breed Health

4/Where do you carry out the slaughter operation ?

Farms (breeders) Butcher's shop Slaughterhouse Any where

5/At what age and weight do you usually slaughter ?

- Age:month -Weight:kg

6/What is the slaughter yield do you get usually ?

-%

7/ Do the carcasses undergo veterinary inspection ?

Yes No

8/What is the purchasing format of rabbit ?

Whole carcass Portion cuts

//General information about selling and marketing of rabbit meat

9/ Who are your clientele ?

Householders Restaurants + Householders + Hotels Private individuals Bars

10/ What is the price of one kilogram of rabbit meat ?.....DA/kg.

11/What is the number of carcasses sold per week?

- carcass/week

12/ In which periods the marketing of rabbit meat increase?

Ramadhan Summer Winter Ramadhan+winter Religious festivals / year-end holidays

13/ What do you think about the marketing situation of rabbit meat?

Bad Fair Good

14/ According to you, what are the main obstacles of rabbit meat marketing ?

- Unavailability of rabbit meat
- High selling price
- High cost production
- Lack of knowledge and awareness

15/According to you, what are the proposal solutions for enhancing rabbit meat marketability ?

.....

THANK YOU FOR YOUR KIND COLLABORATION.