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CHARACTERIZATION OF RABBITS OF LOCAL ALGERIAN POPULATION: REPRODUCTIVE PERFORMANCES, GROWTH AND CARCASS TRAITS

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ABSTRACT

The aim of this experiment was to characterise the reproductive performances, growth and carcass trait of rabbits of local Algerian population keep under a controlled breeding. In total, 35 females and 35 kits aged of 30 days were used in this study for the reproductive performances and growth, respectively. The weight of females at mating was 2803g and was significantly affected by the parity and physiological status of the females. The nonlactating and multiparous females presented the higher weight at mating (P<0.05). The litter size at birth in this study was 6.1 kits. Multiparous females have shown a significantly higher litter size compared to nulliparous and primiparous females (7.5 *vs.* 5.8 kits and 7.5 *vs.* 6 kits, respectively; P<0.05). On other side, average daily gain was 27.21g. Also, the daily feed intake increased by age, from 54.12g/d in the first week post weaning to 139.62g/d at slaughter. The weight of rabbit at slaughter, the weight of hot carcass and the dressing out percentage were respectively 2138 g, 1463g and 69%. In conclusion, the performances obtained is this study allow to classify rabbit of local Algerian population as medium size rabbit with lower performances of litter size and growth which can be improved by genetic selection.

***Keywords* :** Algeria, growth, local population, reproduction, rabbits.

Introduction

Rabbit meat is considered as healthful food product. It has a higher protein level, low cholesterol and fat content (Dalle Zotee, 2000; Aboah and Lees, 2020).The rabbit can be an important source of meat at a lower cost because of its many advantages, such as effortless starting and management, flexible investment, producing high quality meat, and creating jobs for rural people, especially women, younger or aged people (Wu and Lukefahr, 2021).Indeed, the prolificacy of this specie is an asset (51.8 rabbits produced per female per year), so the annual meat production provided by a rabbit represents 25 to 35 times its weight, which corresponds to 130 kg of carcass per year, with a meat yield, largely superior to that of all other herbivorous animals (Lebas, 2007; Jentzer, 2008). In 2019, the total rabbit meat production reached 1.41 million tonnes with European countries participation for only 12.11%, but Asian countries dominating with a rate of 81.75% (Wu and Lukefahr, 2021). In Algeria the rabbit marketing is still modest, not organised or structured. It is practiced on a small scale (Sanah *et al.*, 2022). The rabbit farming is essentially based on the breeding of rabbits from the local Algerian population in order to ensure a supply of proteins to urban markets at a lower cost. This population has always shown a good adaptation to local climatic changes, good meat quality but lower live weight (Gacem and Bolet, 2005; Zerrouki *et al.*, 2014). In order to the develop rabbit meat production based on the use of rabbit of local population, several studies were undertaken in Algeria for its characterization (Mefti *et al*., 2010; Benali *et al*., 2011; Moumen *et al*., 2016; Belabbas *et al*., 2021). The purpose of these studies was the characterization of the animal, its biological and zoo technical aptitudes. However, the majority of these studies were based on the use of rabbits obtained from different rural farms in which the animals are sometimes crossed whit other lines.

Thus, the objective of the present work is to characterize the reproductive performances, growth and carcass traits at slaughter age in rabbits of locale Algerian population keep under controlled breeding.

Materials and Methods

The present study was carried out at the Experimental Rabbity of the University Blida 1 (Algeria). All experimental procedures involving animals were approved by the Scientific Committee of the Institute of Veterinary Sciences, University Blida 1.

Animals

The females were obtained from the Livestock Technical Institute (ITELV Bab Ali, Algeria) (Figure 1). The Local Algerian population was generated from breeding stock received from different Algerian counties (Ain el Benian, Ain M'Lila, Sidi Belabes, Blida, Constantine, Djelfa, Ksar Chelala, Tiaret and Tizi Ouzou) in 1988. The animals were divided into groups according to their origins, kept in closed groups and mated following a rotary intersection plan among groups. The rotation began in 1988 and closed in 2005.

Fig. 1: Rabbits of local Algerian population.

Experiment 1

In total, 35 nulliparous females of local Algerian population were used in this experiment. Females were housed in individually in flatdeck cages. The criteria of selection were the age (4.5 months), the average live weight at mating (2683 ± 225g) and a good sanitary condition. Seven males from the same population (3255 ± 252g) were used to mate females three times a week and a one-day rest between two consecutive matings.

At the mating time, each female was transferred to the male's cage, and left with males about 5-10 minutes. After success of the first copulation, the female is returned to their cage. Pregnancytest was carried out by abdominal palpation on day 12 after mating. For the second and the third parity, the females were mated at 12 days after parturition. Litters were reared by their dams up to weaning (35 days of age). At weaning, rabbits were individually identified and placed in collective cages.

The females were kept under controlled photoperiod with 16 hours of light: 8 hours of dark. Temperature and humidity 25°C and 67%, respectively. During the whole experimental period, females were fed *ad libitum* whit commercial pelleted diet containing 15.89% of crude protein and 15% of crude fibers. Females had a free access to water.

Measured parameters were: litter size: measured as the total number of kits born; number born alive: measured as the number of kits born alive; mortality at birth: measured as the number of kits found dead the day of parturition.

Experiment 2

In total, 35 rabbits aged of 30 days and from the local Algerian population were used. They were housed in individual cages (46 cm×26 cm×33 cm). The rabbits were fed *ad libitum* with a commercial pelleted diet containing 15.90% of crude protein, 13% of crude cellulose and 3% of fat matter. Growth traits were recorded weekly from day 30 to slaughter (91 days): live body weight, mortality, food consumption, average daily gain and feed conversion ratio.

At 94 days, 30 rabbits were weighted and slaughtered without prior fasting. The slaughtering and carcass traits were recorded according to recommendations of the World Rabbit Science Association recommendations described by Blasco *et al.* (1993), except for sleeves were kept to conform to the commercial regulations in Algerian markets (Lounaouci, 2001).

The slaughtered rabbits were bled, skinned, and emptied of the digestive tract and urogenital organs before being weighted. The measures included weigh of hot carcasses, the liver weight and the weight of the full gastrointestinal tract which were took 30 minutes after slaughter. The weight of the chilled carcasses was determined after keeping the carcasses cool for 24 hours at 4°C which allows calculating the dressing out percentage (weight of chilled carcass on weight at slaughter), weight of perirenal fat and the weight of scapular fat. The degree of maturity was estimated by the ratio of the slaughter weight to the average live weight of the local population rabbit at adult age (2900 g).

Head was separated from the carcass. The carcass was the cut between the last thoracic and the first lumbar vertebrae and between the 6^{th} and 7^{th} lumbar vertebrae, resulting in three parts: fore, intermediate, and hind.

Statistical analyses

The results are described by the mean and standard error. The Mixed procedure of the statistical package SAS was used (SAS Institute, 2022). The following model was used to analyse the data in relation with the reproductive performances of the females:

$$y_{ijklm}=\mu+P_i+L_j+S_k+p_{ijkl}+e_{ijklm}$$

μ was the mean; P_i was the parity effect with 3 levels (nulliparous, primiparous and multiparous), L_j was lactation effect with three levels (nulliparous, lactating and nonlactating females), S_k was the season effect with two levels (summer and autumn), p_{ijkl} was the environment permanent effect and e_{ijklm} was the error.

Results and Discussion

Reproductive performances of females

The reproductive performances of the females, recorded during the first three parities, are presented in table 1. The average female's weight at mating was 2803g, value in the same rage with those previously reported for this population by Zerrouki *et al.* (2005).

Table 1 : Reproductive performances rabbit does of local Algerian population (mean±SE).

	n=34	Parity	Lactation	Season
WFM, g	2803,42 ± 38,44	*<0.0001*	*0.01*	*NS*
LSB	6,61 ± 0,29	*<0.05*	*NS*	*NS*
NBA	6,48 ± 0,26	*<0.001*	*NS*	*NS*
Mortality	0,16 ± 0,19	*NS*	*NS*	*NS*
Stillbirth, %	0,57 ± 1,99	*NS*	*NS*	*NS*

WFM: weigh of the female at mating; LSB: litter size at birth; NBA: number of alive kits size at birth; NS: non significant.

Primiparous females had significantly lower weights at mating compared to nulliparous females (-5%; P<0.05) and to multiparous females (-10%; P<0.05) (figure 2). These results are in agreement with those reported by several authors, who point out that nulliparous rabbits are generally mated at the first time when they reach 2/3 of their adult weight (Perrier and Chevallier., 1984). The parity affects alsothe energy balance of females. Feed consumption is higher in multiparous females than in primiparous ones (+10-20%; Fortun- Lamothe and Gidenne., 2003; Fortun-Lamothe, 2006). Therefore, at the primiparous stage, the rabbit must cover her needs for unfinished growth, lactation and lactation and ensure a new gestation. In addition, after the first parturition, the feed consumption increases rapidly (60 to 70%), but remains insufficient to cover all the female's needs (Berchiche *et al*., 2000; Castellini *et al*., 2010). Unlike primiparous rabbits, multiparous females are usually considered capable of ingesting higher quantities of feed required to attain protein equilibrium and body energy (Xiccato *et al*., 2004).

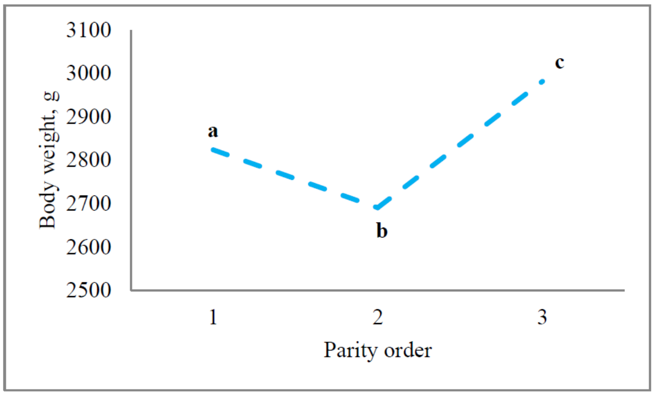

Fig. 2 : Effect of lactation on body weight of females. a, b, c: values follow with different letters are significantly different at P<0.05.

Similarly, the effect of lactation was highly significant on the female's weight at mating. Indeed, lactating females had a significantly lower weight compared to non-lactating females (2772 *vs.* 2891 g, a significant difference of 4%; P<0.05) (Figure 3). Our results agree with those reported in literature explaining that during lactation, the female's feed intake increases but it is insufficient to cover the requirements due to the milk production (Fortun-Lamothe, 2006). Sokr *et al.* (2010) reported that nonlactating females had more body energy reserve than lactating. These authors showed that decreased of milk production for a week (pre-weaning) was enough to improve slightly their energy reserves. As a result, protein content and body lipids are higher in non-lactating females. Also, the energy deficit increases when females are concurrently pregnant and lactating (Parigi-Bini *et al.,* 1992). These two physiological functions, especially lactation, are very costly in terms of energy (Fortun-Lamothe, 2006). That is why, the primiparous does cannot entirely meet the high nutritional demands of lactation and usually prove an energy deficit (Xiccato *et al.,* 2004) which reduces their body fat depots and is partially responsible for their low reproductive performance (Castellini *et al.,* 2006). For that reason, the energy balance of does is more negative during the first lactation than for following lactations (Bolet and Fortun-Lamothe, 2002). Finally, the weight of the females did not vary significantly between the two studied seasons.

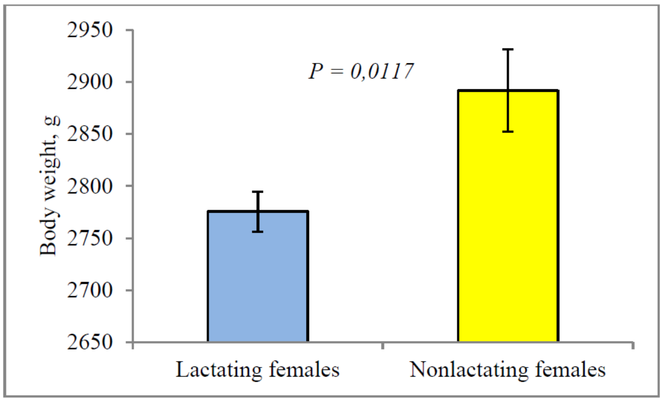

Fig. 3: Weight of lactating and nonlactating females.

In this experiment, the total and alive kits at birth were 6.6 and 6.48 kits respectively. These values were similar to that reported by literature (Gacem *et al*., 2009; Alliane and Mekked, 2003) but lower (-11%) than that noted recently by Belabbas *et al.* (2021). Other authors cited a difference of -7% for the number of total bornkits but similar results kits born alive (Zerrouki *et al*., 2005; Moulla and Yekhlef, 2007; Abdelli *et al*., 2014). In the white population of rabbits, 7.1 and 5.8 kits were found, respectively, for litter size at birth and number of born alive (Sid *et al*., 2018). The litter size of the local population is always lower than that of the synthetic strain ITELV2006 (Gacem *et al*., 2009; Sid *et al*., 2018; Ezzeroug *et al*., 2019; Boudour *et al*., 2020; Belabbas *et al*., 2021) and other strains (El-Raffa *et al.,* 2005; Khalil and El-Saef, 2012). This improvement in litter size could be related to a modification in the litter size components traits (Argente, 2016; Belabbas *et al*., 2016; Belabbas *et al*., 2021). The French breed "fauve de Bourgogne" indicated a significantly lower litter size (4.3 kits) than the local population (Savietto *et al*., 2021). However, Hungarian Giant rabbit breed reported, respectively, 9.13 and 8.03 kits for total born and alive kits at birth (Eiben *et al*., 2021).

On other side, the parity of the female has a significant effect on the litter size at birth (Figure 4). Multiparous females have shown a significantly higher litter size compared to nulliparous and primiparous females (7.5 *vs.* 5.8 kits and 7.5 *vs.* 6 kits, respectively). Litter size was similar between nulliparous and primiparous groups. These results corroborate those of other authors showing that litter size in rabbit increases progressively during the different parities, with a maximum value between the 3rd and 5th parity (Rafel *et al.,* 1990; Tuma *et al*., 2010; Mazouzi *et al*., 2012).

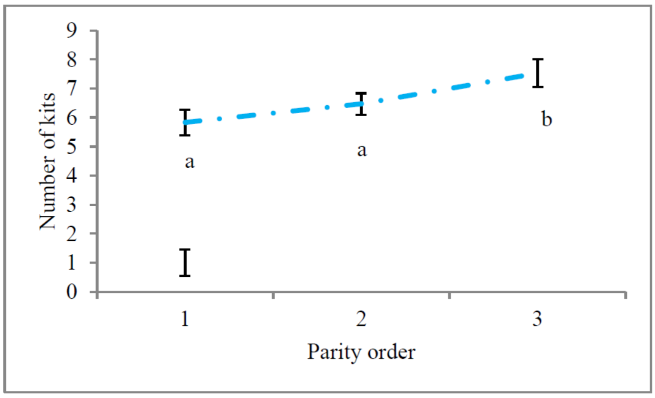

Fig. 4 : Evolution of litter size according to the parity of the female. a, b, c: values follow with different letters are significantly different at P<0.05.

Similarly, the number of kits born alive varied according to the parity of the females (Figure 5). It increased significantly between the nulliparous and primiparous stage (5.4 *vs.* 6.6 kits; P<0.05) and between the primiparous and multiparous stage (6.57 *vs.* 7.46 kits; P<0.05).This is probably related to the improvement of the body condition of the females and a favourable uterine environment for the development of gestation (Afifi *et al*., 1993; Bolet *et al.,* 1999). Finally, the statistical analysis revealed no significant effect on the stillbirth.

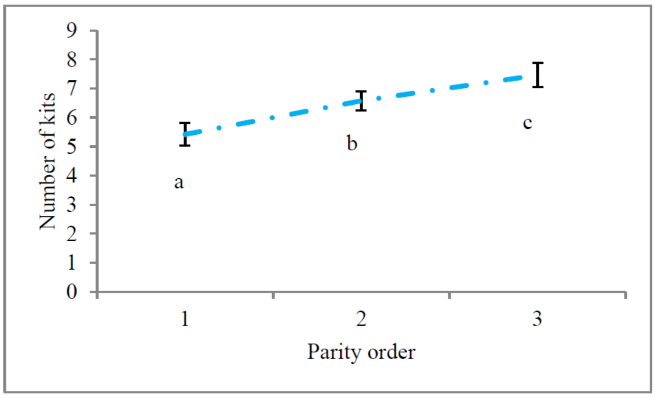

Fig. 5 : Number of kits born alive according to the parity of the female. a, b, c: values follow with different letters are significantly different at P<0.05.

Growth and carcass traits

The mortality rate was 14.2%, value corroborates with those of the literature (9 to 23%; Lakabi *et al.,* 2008; Benali *et al.,* 2011) and 10 to 14% (Lebas, 2005; Alabiso *et al*., 2016; Assan, 2018). The mortality in our study was recorded mainly in the first week after weaning of kits. The dead animals presented only diarrhea, probably due to digestive disorders linked to the stress caused by the weaning process. Digestive disorders are the main source of rabbit mortality just after weaning and are responsible of high economic losses in a rabbit farms (Assan, 2018). El-Ashram *et al.* (2020) reported that 9.63% mortality is related to enteritis in post weaning period.

The evolution live body weight is presented in the figure 6. In this experiment, the evolution of the live body weight from weaning to slaughter was similar to that reported by Benali *et al.* (2011) for two rabbit populations (local and white population). The live weight increases from 700g at 42 days of age to 1000g at the 56th day of age, then it records a weight around 1700g at 79 days to finally reach a weight of 1900g at slaughter (93d) (Belabbas *et al.,* 2019). At weaning, several authors cited similar weight which was approximately 550g (Boudour *et al*., 2020; Belabbas *et al*., 2019). The synthetic strain also has shown the same result (Ezzeroug *et al*., 2019; Belabbas *et al.,* 2019). However, at slaughter, the live body weight was higher than 1700g. According to the bibliography, the result was in the standards obtained in rabbit of local Algerian population. The weight at slaughter was 1.5 to 3 kg at 10 to 14 weeks of age (Sanah *et al.*, 2022; Benabdelaziz *et al.,* 2021).

According to the authors' findings, for the same age, rabbits of local population showed a variation in weights (Berchiche *et al*., 2000; Berchicheet Kadi, 2002; Benali *et al*., 2011).

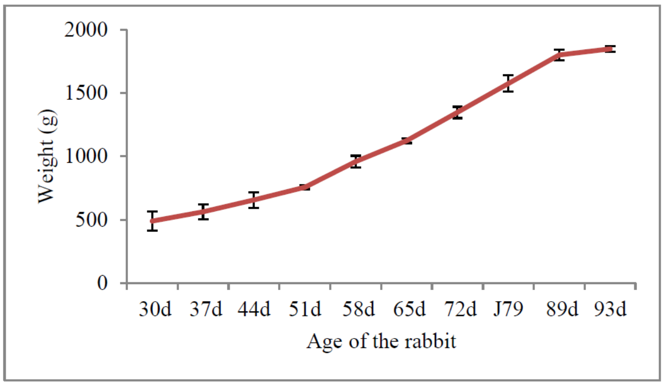

Fig. 6 : Evolution of the live body weight from weaning to slaughter in rabbit of local Algerian population. d = day.

In this experiment, the average daily gain was 27.21g. This value was close to those cited by several authors on different local populations and strains (Lakabi *et al.,* 2008; Benali *et al*., 2011; Belabbas *et al*., 2019); but it was significantly higher than those observed in the local Algerian population by Moulla (2006), Berchiche *et al.* (2000) and Mefti *et al.* (2010) with 20.44, 21.22 g/d and 25.86g/d, respectively. However, it remains low compared to the daily gain obtained by other authors (Capra *et al*., 2013; Belabbas *et al*., 2019). The daily gain increased as the age progressed, which explain the evolution of the weight previously presented.

The daily feed intake increased by age, from 54.12g/d in the first week post weaning to 139.62g/d at slaughter. This evolution corroborates to those noted in two local populations by Benali *et al.* (2011), but the average daily feed intake in the whole experiment period (99.34g/d) was lower than that cited by the same author. The New Zealand White rabbit showed slightly higher daily feed intake (111.5g/d) (Cardinali *et al*., 2015).

The conversion ratio showed increasing values between weaning and slaughter. These results agree with those reported in literature confirming that the feed conversion ratio increases proportionally with the animal's age (Mefti *et al*., 2010; Benali *et al*., 2011). The average value was 3.70 in agreement with Lakabi *et al.* (2008).

Table 2 : Evaluation of the daily gain, daily feed intake and feed conversion ratio according to rabbit's age.

	Daily gain (g)		**Daily feed intake (g)**		**Conversion ratio**	
Periods	n=30	SE	n=30	SE	n=30	SE
30-37d	21.45	0.45	54.12	2.52	1.89	0.01
37-44d	23.84	1.22	61.17	4.75	2.23	0.45
44-51d	25.78	1.32	78.45	6.52	3.09	0.85
51-58d	27.58	0.44	92.75	1.85	3.96	0.41
58-65d	28.16	0.19	102.52	9.74	4.15	0.75
65-72d	28.85	0.18	112.14	4.11	4.15	0.75
72-79d	29.25	0.45	120.56	12.26	4.55	0.42
72-89d	29.79	0.38	132.74	1.85	5.1	0.23
89-93d	30.22	1.36	139.62	10.41	4.2	0.23
30-93d	27.21	0.66	99.34	6.00	3.70	0.45

d: day.

The weights, dressing out percentage and proportions of carcass components of slaughtered rabbits are shown in Table 3. In this experiment, the maturity rate (73.7%) was estimated considering the adult weight of 2900 g (Gacem *et al.*, 2009). The slaughter weight was 2138g, value similar to those recorded by several authors in the same population of rabbits (Benali *et al.*, 2011; Belabbas *et al.*, 2019). However, this result was higher than those reported by Lakabi *et al.* (2008) and Alagon *et al.* (2015), but lower than that reported in synthetic line ITELV2006 by Belabbas *et al.* (2019) (+ 300g).

The weight of hot carcass was 1475g, which is similar to that cited by Belabbas *et al.* (2019) but it is a heavier weight compared at those noted in others tests (Lakabi *et al.,* 2008; Benali *et al*., 2011; Moumen *et al*., 2016). However, for the same rabbit's age, this value was higher than that reported in Chinchilla's carcass (+334 g) and Grey Giant's carcass weight (+418 g) (Ghosh and Mandal, 2008). Concerning, chilled carcass's weight, the result obtained was higher than those reported by other authors for different populations and breeds (Pla *et al.,*1998; Lakabi *et al*., 2008; Benali *et al*., 2011), but Benali *et al.* (2018) pointed out an elevated weight with a mean of 1760g. The difference in the weight of chilled carcasses depends on the weight of the hot carcass, which is linked to the live body weight, as well as the loss of weight during cooling after drying, which can vary from 2 to 4% (Benabdelaziz *et al*., 2021).

On other side, values obtained for the weights of liver and the full gastro-intestinal tract were higher those cited in bibliography (Ghoshet Mandal, 2008; Rotimi *et al.,* 2021). Dressing out percentage of the hot carcass in this experiment was 69%. In north-east of Algeria, the survey conducted by Sanah *et al.* (2022) pointed out similar slaughter yield of 65%. However, Boudour *et al.* (2016) and Moumen *et al.* (2016) noted for the same local population a lower result with 51%. The difference in results for the same population may be related to feed quality, rearing conditions (Moumen *et al.,* 2016). Also, the dressing out differs according to the age at slaughter (Ouhayoun, 1989; Benabdelaziz *et al*., 2021). Indeed, for a difference of 10 days, the yield's difference can be+7% (Ouhayoun, 1989). In the same context, a significantly higher rates were described by other authors (Ghosh and Mandal, 2008; Cardinali *et al*., 2015; Rotimi *et al*., 2021). The variation in dressing out percentage among studies might be related to the use of different genotypes, age and live body weight at slaughter and the carcass definition from country to country. In Europe, the head and feet are part of the carcass, so the rabbit dressing percentage obtained (60-62%) is higher than that in the United States (50%) where head and feet are removed. According to Xiccato *et al.* (2013), stand density and group size affect slaughtering performance. Also, the carcass dressing out percentage obtained in this experiment are satisfactory and within the norms reported in rabbits of medium size (50 to 60%) (Ouhayoun, 1989).

The proportion of full gastro-intestinal tract in this study was 14.2%. This result agrees with the norm described by Ouhayoun (1989) which is 14%. The same author explained that the better performances are related to the lower percentage of the digestive tract. He suggests that the relatively reduced weight of the digestive tract could be a consequence of the extension of the fattening period beyond 77 days of age, knowing that the growth of the digestive tract becomes slower than that of the body growth from 650 g and skin growth from 850 g. Moreover, Benabdelaziz *et al.* (2021) confirmed this with a trial of 3 groups rabbits where the highest yield was attributed to the group with the lowest percentage of full gastro-intestinal tract. Also, Alagon *et al.* (2015) reported a higher percentage for full gastro-intestinal tract (20.2 %) with low dressing out percentage (55%).

The average adiposity of rabbit carcasses represented mainly by perirenal fat in relation to the weight of the cold carcass (Blasco *et al*., 1993). In this experiment, it was obtained a percentage of 1.5% which is similar to that reported by Lakkabi *et al.* (2008) but lower (-2%) then that cited by others authors (Berchiche *et al*., 2000; Alagon *et al*., 2015; Moumen *et al*., 2016). The literature is contradictory concerning the relationship between muscle and adiposity. Petracci *et al.* (1999) observed that the heaviest animals are the fattest. Conversely, Piles *et al.* (2000) noted a decrease in overall apparent fat deposition in rabbits selected on growth rate compared to control animals. According to the experiment conducted by Benabdelaziz *et al.* (2021), and under local Algerian production conditions, breeders produce carcasses with an average fatness.

Table 3 : Slaughter yield components and carcass characteristics of the local population at 13 weeks of age

Traits	Rabbits (n=30)	SEM
Maturity rate,%	73.72	4.68
Weights (g)		
Slaughter weight (SW)	2138.3	135.69
Skin (S)	203.34	38.08
Full gastro-intestinal tract(FGIT)	305.55	72.44
Hot carcass (HC)	1475.89	86.13
Chilled carcass (CC)	1436.39	86.80
Scapular fat (SF)	7.74	1.54
Perirenal fat (PF)	21.51	3.69
Liver (L)	69.52	7.41
Dressing out (%)		
HC/SW	69.02	0.4
CC/SW	67.29	3.8
Proportions (%)		
S/SW	9.46	1.36
FGIT/SW	14.2	2.90
PF/CC	1.5	0.25
SF/CC	0.54	0.10
L/CC	4.84	0.49

Conclusions

In summary, concerning the relationships between parity order and reproductive traits, our results agreed with existing literature showing a greater weight of the females and higher litter size in multiparous stage. The weight of females is affected by its physiological status and the lighter weight was recorded in the nonlactating females.

The study of the growth allowed us to confirm once again that the rabbit's live body weight of the local Algerian population is in the range of those belong to the small category of breeds. The evolution of the weight, between weaning and slaughter, corroborate to the literature with an increased progress of the feed conversion ratio. The carcass yield of this rabbit population was higher and can be an interesting criterion for genetic selection.

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