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Bísaro Pig

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Abstract

Local pig breeds are adapted to the specific local environment and fed with various locally available feedstuffs. So besides their genetic merit for agro-biodiversity, they represent the foundations of sustainable local pork chains. Thus, the aim of the current chapter is to present the history and current status of the Bísara breed (Bísaro pig), its exterior phenotypic characteristics, geographical location, production system and main products from this Portuguese autochthonous breed of pigs. Moreover, a collection and review of available literature data, set until August 2017, on reproductive and productive traits (growth, carcass, meat and fat quality) of Bísaro pig breed were carried out. Reproductive performance has been estimated by means of sow's age at the first parturition, annual litters per sow, piglets alive per litter, piglet live birth and weaning weight, percentage of stillborn per litter, mortality to weaning, lactation length and farrowing interval. Growth performance has been estimated through the average daily gain and feed intake in both the growing stage and the early, middle, late and overall fattening stage. Carcass traits have been evaluated by means of age and weight at slaughter, hot carcass weight, carcass yield, lean meat content, backfat thickness at withers, last rib, above the muscle *gluteus medius* and the loin eye area. Meat and fat quality traits of *longissimus* muscle have been evaluated by means of pH at 45 minutes and 24 h after slaughter, objective colour (CIE L*), intramuscular fat content and fatty acid composition of intramuscular fat. Although a considerable number of studies on Bísaro pig were included in the current review, data on meat and fat quality are scarce.

Keywords: traditional European breed, TREASURE, productive traits, phenotype, Portugal

1. History and the current status of the breed (census)

The Bísaro pig is a Portuguese native breed belonging to the Celtic line—*sus Celtics* [1, 2]—that was maintained in its primitive state throughout the North of Portugal until the mid-twentieth century [3, 4]. This breed presents a slow growth, unfavourable carcass conformation and medium fat and has always been recognized for its high prolificacy, excellent sensorial quality of meat and aptitude for processing typical products. In the second half of the last century, industrialization of the livestock production has changed meat consumption patterns, and the Bísara breed has declined to be replaced by more productive breeds originating from the centre and north of Europe and Asia. In the 1990s, this breed was practically extinct and reduced to only about 100 breeding stock in small farmers in the North of Portugal. The first conservation and recovery programme for the Bísaro breed was approved and supported by the

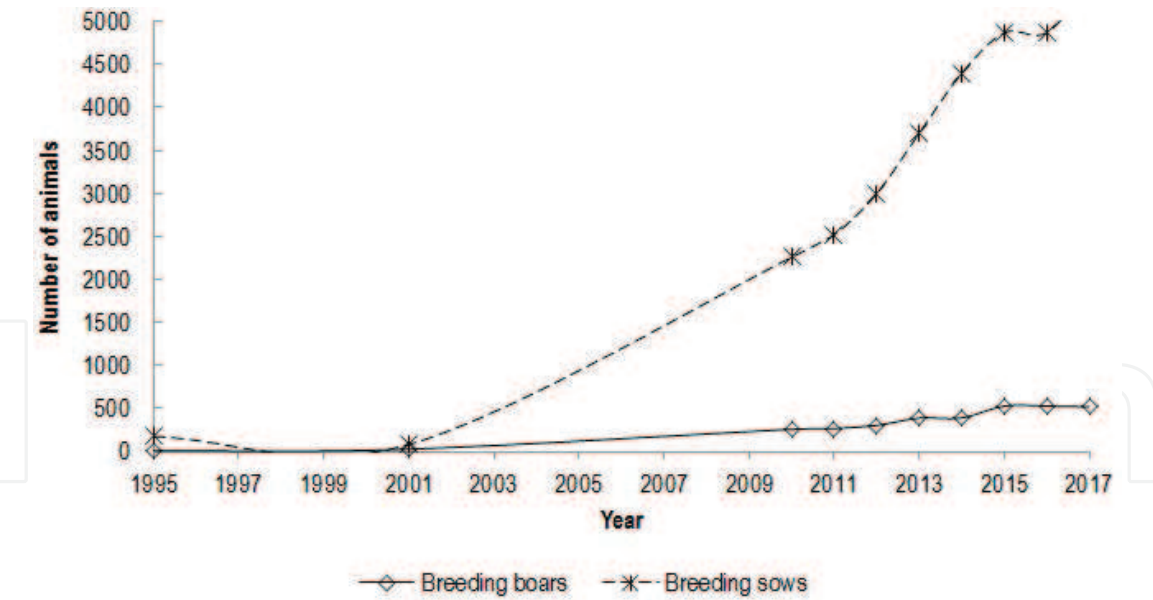


Figure 1.
Census of Bísaro breed, presenting a number of sows and boars per year, starting with the year of the herdbook establishment.

Portuguese government in the 1990s [5]. From here, and following the establishment of the National Association for Bísaro Pig Breeders (ANCSUB) in 1994, the Bísaro pigs increased in number once again. In 1996, a national plan for conservation and characterization of the breed was launched (project PAMAF 7173). This plan allowed the first regional census of the breed and the selection of some of the few existing breeding animals to form the two experimental conservation nuclei “in vivo” and “in situ” (in Guimarães and Montalegre, respectively). From these two nuclei, some descending piglets were sent to the National Zootechnical Station (EZN, in Santarém), where individual performance tests were performed to characterize the growth and quality of the meat. The results of the performance tests, together with DNA analysis on animals, allowed the selection of some Bísaro pigs to return to the conservational nuclei for breeding and made available to the producers for commercial use. After the PAMAF programme, others followed (AGRO 247 and AGRO 339), which allowed the work of characterization to continue and assist the producers’ knowledge and to develop the breed until the present day. The census of Bísaro pig breed is presented in **Figure 1**. In August 2017, according to the breed herdbook, there were 189 registered farms of Bísaro pigs with 5460 breeding sows and 520 boars and an average heard size of 29 animals.

Today this breed is indexed to a diversity of European protected products (<https://tradicional.dgadr.gov.pt/pt/pesquisa?searchword=bisaro&searchphrase=all>), and the maintenance or an increase of the Bísaro population is expected. Nowadays the Bísaro pig is reared in a variety of production systems, mainly in small family farms or in medium-sized outdoor or semi-extensive farms.

2. Exterior phenotypic characteristics

The Bísaro pig breed has a large body and long legs, with flat sides, strong shoulders and a big head. They have very long and floppy ears covering the eyes, a long and concave snout and a convex back. This local pig breed has several varieties of skin colour; they can be grey or black and white or spotted. The Bísaro has a docile temperament, is slow and somewhat clumsy and is characterized by a convex back and large drooping ears. There are two varieties of Bísaro pig in Portugal: a white-spotted one, common in Minho, and a black- to grey- or black-spotted one, found in Minho,

Trás-os-Montes and Beiras [6]. The average live weight of adult Bísaro pigs varies between 180 kg in males and 150 kg in females; the values of the height at withers vary between 97 and 89 cm, respectively (**Table 1; Figures 2 and 3**).

Measurement (average)	Adult male	Adult female
Body weight (kg)	180	150
Body length ¹ (cm)	190	170
Head length (cm)	45	40
Tail length (cm)	60	55
Ear length	Extra large	Extra large
Chest girth (cm)	170	150
Height at withers (cm)	97	89
Number of teats	—	≥12

¹Measured from the tip of the nose to the starting point of the tail.

Table 1.
Summary of morphology information on Bísara breed.



Figure 2.
Bísaro sow with piglets.



Figure 3.
Bísaro boar.

3. Geographical location and production system

The Bísara breed is scattered throughout the northern of Portugal, from the Tagus River to the border with Galicia (in Spain), but the highest concentration of farms and animals can be observed over the Douro River (Trás-os-Montes and Minho regions). Traditionally, Bísaro pigs were kept in very small family farms (1–2 sows per farm) where the pig is often considered an economic supplement for self-consumption and/or for processing artisanal products, sold directly to consumers and/or in small regional fairs (short supply chains) [7]. The traditional Bísaro feeding system includes diets based on a mixture of cereals (corn, wheat, barley, bran, triticale, others) and a large variety of forage foods, such as tubers (potatoes, turnips, beets), vegetables (cabbages, pumpkins, carrots) and grazing areas, where pigs can pasture different kinds of herbs and wild fruits (chestnuts and acorns). The nature of the raw feeds used in the traditional diets is a limiting factor of the herd size. Thus, the very small scale of the pig farms and the rudimentary buildings and animal facilities, which are poorly dimensioned, are the main weakness of this production system, limiting the farms' productivity and possibly impairing animal welfare.

Nowadays, the average number of sows per farm is 30 (ANCSUB, personal communication), raised in traditional family farms (50%) and kept in semi-intensive outdoors or semi-extensive systems. In some cases, the housing systems combine housed (confined) and outdoor rearing systems according to the different physiological stage of the animals. Normally, lactating sows and piglets are confined (housed) in maternities, while pregnant sows are reared outdoors or in semi-confinement [7]. Typically, fattening of Bísaro pigs to obtain high-quality meat products includes two growing phases: first, a fast to moderate growth up to 70–75 kg live weight (LW) and, second, a fattening-finishing phase until 120–180 kg LW, with variable diets depending on the availability of local food resources on specific farm and region. As alternatives to improve the traditional food, the incorporation of external input, for instance, cereals and food concentrates, has been developed. Growers and finishing pigs can be reared in mixed systems where animals are confined in an open-air park or in an enclosed stable with access to grazing areas of various sizes, depending on the availability of pastures and clumps. The growing-finishing phase can be classified as intensive, semi-extensive or extensive depending on the available pasture area and the stocking rate. The goal of the TREASURE project for the Bísaro pig in Portugal was to study the effect of outdoor production systems and to test some traditional agricultural crops in the fattening of Bísaro pigs and their impact on the quality of pork.

4. Organisations for breeding, monitoring and conservation

The National Association for Bísaro pig breeders (ANCSUB¹) was created in 1994, and in March 1995, the Ministry of Agriculture recognized it to establish the herdbook and its regulation. ANCSUB aims to preserve and enhance the production of the Bísaro pig and meat products and to conduct the genetical management of the Bísaro breed and its herdbook. ANCSUB ensures technical support and animal management services to breeders, such as animal identification and health services (vaccination and deworming), technical support in protection and certification of PGI and PDO products and organization of technical meetings.

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5. Productive performance

5.1 Reproductive traits

The use of a boar in small pig farms entails high economic costs. This is why some farms (less 5% of the farm and less of 20% of sows) are using A.I. with semen purchased from a semen collection centre. However, due to the great distance from the pig farms, there are logistic problems related with the shipment of the seminal doses that affect the efficiency of A.I. [8]. To improve the results of A.I., it is advisable to improve the transport and storage of semen to the farms, as well as to promote training of farmers in reproductive management, namely, the identification of the best moment for insemination. In contrast, in small family farms (1–2 breeding sows), mating of Bísaro sows takes place in community facilities, by “the village boar”. The sow is moved to the community farm for several days, until pregnancy is confirmed. Despite being economically advantageous, this reproduction system brings other technical problems such as increased inbreeding and farrowing interval and the risk of contagious diseases [9].

Table 2 summarizes some available data on the breeding characteristics of the Bísara breed. For each study, the number of animals tested and the mean values recorded for each trait are given. In general, the analysed studies report that the first parturition of Bísara sows occurs between 10 [9] and 12 months of age [10] (11.2 months in average). On average, Bísara sows have 1.9 litters per year (ranging from 1.5 [9] to 2.2 [12]) with 9.3 piglets born per litter (variation 6.9 [10] to 12 [9]), weighing approximately 1.8 kg at birth [5, 10, 12] and 7.2 [12] to 11.1 kg at weaning [10]. Traditionally weaning is performed 60 days after birth [9], but can vary from 28 [12] to 60 days, depending on the intensity of breeding practices. The mortality rate of piglets is very variable in the available studies, ranging from 5 [12] to 11% at birth [10] and 14 [12] to 35% at weaning [10]. In the traditional and extensive production systems, the interval between parturitions is prolonged as a consequence of farmer’s management decisions, such as the increase in the age at weaning (from 28 days usual for intensive systems [12] to 60 days in the traditional system [9]) and more extensive rearing and feeding conditions. In this case the piglets are sold with higher weights and for higher price. However, this system is more demanding for sows which are forced to mobilise body reserves to a much greater extent, during lactation and the first third of gestation.

5.2 Growth performance

In the traditional farms, Bísaro pigs are fed with local agricultural crops, usually produced on farm. The feed regime for fattening animals is closely linked to the products and by-products of plants and forages of each region which is dependent on the annual cycles and harvests. Generally, in traditional system Bísaro pigs are fattened slowly and slaughtered between 1 and 2 years of age, reaching a high but variable slaughter weight (between 120 and 180 kg), which is scheduled for the coldest months of the year (between November and February).

Basic data on growth performance are presented in **Tables 3** and **4**. For each study the number of animals used is presented. Large differences have been found between studies with regard to the live weight range covered. Therefore, we defined the stages for growth performance as growing stage (from weaning to approximately 30 kg live body weight) and early, middle and late fattening stages estimated between approximately 30 and 60 kg, 60 and 100 kg and above 100 kg live body weight, respectively. Sometimes the source provided only the overall growth rate for the whole fattening stage (herein defined as overall). It should also be noted that most collected studies simulated the conditions of the production system used and that only a small part of the studies

Reference	Production system	No. of sows	Age at the first parturition (mth)	Litters per sow per year	No. piglets alive per litter	Piglet live weight (kg)	Still born per litter (%)	Mortality at weaning (%)	Piglet weaning weight (kg)	Duration of lactation (d)	Farrowing interval (d)
[5]	Intensive, outdoor	21	11.6	1.6	9.1	1.8	9.8	29.4	8.6	42	200
[9]	Traditional	4	10.0	1.5	12.0	—	8.3	16.6	—	60	232
[10]	Intensive, outdoor	14	11.9	—	6.9	1.7	11.0	34.8	11.1	52	—
[11]	Intensive, outdoor	32	—	1.8	8.7	—	—	20.5	—	—	203
[12]	Semi-intensive, outdoor	11	11.3	2.2	10.0	1.7	5.0	14.3	7.2	28	162

No. = number, mth = month, d = days.

Table 2.
Summary of collected literature data on reproduction traits in Bísara breed.

Reference	Feeding regime and production system	No. of animals	ADG growing ¹	ADG fattening ²			
				Early	Middle	Late	Overall
[10]	Semi; outdoor	13	—	—	—	—	514
[13]	Semi (100% concentrate)	6	—	513*	641	—	577
	Rest (75% concentrate +4 kg/day herb)	8	—	—	467	—	490
	Rest (50% concentrate +4 kg/day herb)	8	—	—	356	—	435
[14]	Semi; individual housing—performance test	24	—	—	559	534	559
[15]	Semi; closed pavilion	38	—	—	—	—	593
	Semi; outdoor	10	—	—	—	—	460
	Semi; traditional stable	30	—	—	—	—	653
	Rest; outdoor	20	—	—	—	—	345
	Rest; outdoor	20	—	—	—	—	343
[16]	Semi; outdoor	22	—	—	431	—	431
[17]	Semi; hoop-barn, outdoor	10	546	—	—	—	535
	Semi; traditional stable	10	563	—	—	—	505

No. = number, ADG = average daily gain in g, Semi = semi ad libitum feeding regime, Rest = restrictive feeding regime.
¹ADG in growing period estimated from weaning to approximately 30 kg live body weight.
²ADG in a period of fattening is reported for early, middle and late fattening stages estimated between approximately 30 and 60 kg, 60 and 100 kg and above 100 kg live body weight, respectively. Sometimes the source provided only the overall growth rate for the whole studied period (in that case defined as overall).
*Recorded on 22 animals.

Table 3.
Summary of collected literature data on the average daily gain (in g) in Bísara breed.

actually aimed at evaluating the breed potential for growth. In the considered studies, data on growth performance during lactation are missing. Daily gain in the growing stage varies between 546 and 563 g/day [17]. The early, middle and late fattening stages are characterized by moderate growth (513 g/day [13], 356–641 g/day [14] or 534 g/day [16]). In the overall fattening stage, for which data are available in most studies, moderate growth and big heterogeneity are observed (ranging between 343 and 653 g/day) [10, 13–17] which could be due to the fact that this review comprises studies performed in different production systems and using varying feeding levels.

The available information on Bísaro’s feed intake and feed nutritional value is scarce, which limits the evaluation of the Bísaro growth potential. Average daily feed intake increases from approximately 1.7 kg/day in the growing stage to a maximum of 2.7 kg/day in the middle fattening stage [16] and 2.6 kg/day in the late fattening stage [14] when a semi ad libitum feeding regime was applied. In contrast, in the overall fattening stage, the average feed intake varied between 1.8 and 2.6 kg/day [10, 14, 15, 17].

5.3 Body composition and carcass traits

Table 5 presents the basic data regarding some of the most commonly measured carcass traits. The number of animals included in each study is given whenever possible. In general, the breed, age and weight at slaughter, the climatic conditions,

Reference	Feeding regime and production system	ME content of feed (MJ/kg)	CP content of feed (%)	No. of animals	ADFI growing ¹	ADFI fattening ²		
						Middle	Late	Overall
[10]	Semi; outdoor	13	13.8	13	—	—	—	2.04
[13]	Semi; outdoor	12	16	6	—	2.70	—	—
	Semi; traditional stable	12	16	8	—	1.80	—	—
	Rest; outdoor	12	16	8	—	0.90	—	—
[14]	Semi; individual housing—performance test	12	16	24	—	2.05	2.62	2.05
[15]	Semi; individual housing—performance test	—	—	38	—	—	—	2.06
[16]	Semi; outdoor	12	15	22	—	2.70	—	—
[17]	Semi; hoop-barn outdoor	—	—	10	1.70	—	—	1.84
	Semi; traditional stable	—	—	10	1.76	—	—	1.78

No. = number; ADFI = average daily feed intake in kg/day, Semi = semi ad libitum feeding regime, Rest = restrictive feeding regime, ME = metabolisable energy, CP = crude protein.
¹ADFI in a growing period estimated from weaning to approximately 30 kg live body weight.
²ADFI in a period of fattening is reported for early, middle and late fattening stages estimated between approximately 30 and 60 kg, 60 and 100 kg and above 100 kg live body weight, respectively. Sometimes the source provided only the overall growth rate for the whole studied period (in that case defined as overall).

Table 4.
Summary of collected literature data on average daily feed intake (in kg/day) in Bísara breed.

the use of regional raw materials (acorns, oaks, chestnuts, grass and agricultural by-products) and the exercise of animals during grazing are the main differentiating factors of meat quality compared to modern pig breeds reared in intensive system. Traditionally, Bísaro pigs are slaughtered at weights well above the age of sexual maturity, when muscle growth has stabilized at the expense of greater capacity of deposition and infiltration of intramuscular fat (+60% monounsaturated fatty acids), an essential condition in order to develop the organoleptic characteristics that are highly valued by consumers [19].

Three studies report that Bísaro pigs were slaughtered between 282 and 333 days of age [15, 16, 18], while in the other studies, the age of pigs is missing. Considering information available in all studies, animals are slaughtered between 88 and 124 kg live weight, and dressing yield ranges from 73.4 to 77.6% [10, 13–16, 18]. The backfat thickness at withers ranged from 45 to 62 mm [10, 18] and at the level of the last rib from 19 to 42 mm [10, 13–16, 18]. Also, muscularity, measured as the lean meat content (either by SEUROP classification or dissection), varied from 46.1 to 51.0% [10, 13, 15, 16] and the loin eye area from 29 to 40 cm² [13, 14], which indicates good muscular development compared to other traditional breeds. Variation in backfat and muscle thickness may be a consequence of the wide range of final live weight of pigs and different feeding regimes applied in different experiments.

Reference	No. of animals	Final age (d)	Final BW (kg)	Hot CW (kg)	Dressing yield (%)	Lean meat content (%)	Backfat thickness (mm)			Loin eye area (cm ²)
							S ¹	At withers	At the last rib	
[10]	13	—	99	75	76.3	46.1	—	45	25	—
	6	—	88	68	76.7	46.8	—	—	—	—
[13]	6	—	116	90	77.6	46.3	—	—	31	40
	8	—	108	82	75.9	48.5	—	—	24	40
	8	—	102	76	74.7	49.4	—	—	22	36
[14]	12	—	106	81	77.0	—	—	—	20	29
[15]	13	333	105	81	76.9	51.0	—	—	19	—
	10		112	83	74.0	49.9	—	—	20	—
	20		106	78	73.4	48.7	—	—	19	—
[16]	22	325	106	78	73.4	48.6	—	—	21	—
[18]	18	282	124	94	75.5	—	46	62	42	—

No. = number; BW = body weight; CW = carcass weight.
¹Backfat thicknesses measured according to ZP method (above the gluteus medius muscle (mm)).

Table 5.
Summary of collected literature data on body composition and carcass traits in Bísara breed.

5.4 Meat and fat quality

Table 6 summarizes the basic data available for some of the most commonly measured meat and fat quality traits in *longissimus* muscle. In studies reporting the Bísaro meat quality, pH measured in *longissimus* muscle at 45 minutes and 24 h *post-mortem* varied between 5.95 and 6.34 and 5.32 and 5.56, respectively [13, 14]. Other data on meat quality were scarce. The intramuscular fat content was determined only in two studies and range from 2.6 to 2.7% [14, 16], whereas only one study referred to meat colour (Minolta L value; L* = 54 [14]). Regarding fat composition,

Reference	No. of animals	pH 45	pH 24	CIE L ¹	IMF content (%)	Fatty acid composition ² (%)			
						SFA	MUFA	PUFA	n-6/n-3
[13]	6	6.04	5.32	—	—	—	—	—	—
	8	6.23	5.37	—	—	—	—	—	—
	8	6.34	5.38	—	—	—	—	—	—
[14]	12	5.95	5.56	54	2.6	—	—	—	—
[16]	22	—	—	—	2.7	—	—	—	—
[20]	—	—	—	—	—	40	47	13	12

No. = number; pH 45 = pH measured approximately 45 minutes post-mortem, pH 24 = pH measured approximately 24 h post-mortem, IMF = intramuscular fat, SFA = saturated fatty acids, MUFA = monounsaturated fatty acids, PUFA = polyunsaturated fatty acids.
¹CIE = objective colour defined by the Commission Internationale de l'Eclairage; L* greater value indicates a lighter colour.
²For fatty acid composition, only pigs on control diets were considered. Control diets differed among studies, to see diet composition address to the corresponding source.

Table 6.
Summary of collected literature data on meat and fat quality traits measured in *longissimus* muscle from pigs of Bísara breed.

one study discriminates the fatty acid content in MUFA (47%), PUFA (13%) and SFA (40%), together with a n-6/n-3 ratio of 12 [20]. It should be noted that the values mentioned in the experiments respect to Bísaro pigs under controlled conditions, which may be quite different from those obtained in traditional production systems and at heavier weights, around 160 kg.

6. Use of breed and main products

Bísaro pork is much appreciated in Portugal, with many gastronomical uses. Meat is consumed in fresh on a wide variety of traditional dishes or transformed into a large number of traditional smoke cured products, such as *chouriços*, *salpicões*, *presunto* (ham) and other traditional products. Besides the diverse PDO and PGI products created from Bísaro pork (Table 7), Bísaro meat is valued in the traditional cuisine, such as roast piglets or *cozido à portuguesa* cooked from heavy pigs.

Type of the product	Name of the product	Status of the product
Fresh meat	<i>Carne de Bísaro Transmontano</i>	PT/PDO
Cured meat product	<i>Alheira de Barroso-Montalegre</i>	PT/PGI
	<i>Alheira de Vinhais</i>	
	<i>Butelo de Vinhais; Bucho de Vinhais; Chouriço de Ossos de Vinhais</i>	
	<i>Chouriça de Carne de Barroso-Montalegre</i>	
	<i>Chouriça de Carne de Melgaço</i>	
	<i>Chouriça de Carne de Vinhais; Linguiça de Vinhais</i>	
	<i>Chouriça de sangue de Melgaço</i>	
	<i>Chouriça Doce de Vinhais</i>	
	<i>Chouriço Azedo de Vinhais; Azedo de Vinhais; Chouriço de Pão de Vinhais</i>	
	<i>Chouriço de Abóbora de Barroso-Montalegre</i>	
	<i>Presunto de Barroso</i>	
	<i>Presunto de Melgaço</i>	
	<i>Presunto de Vinhais/Presunto Bísaro de Vinhais</i>	
	<i>Salpicão de Barroso-Montalegre</i>	
	<i>Salpicão de Melgaço</i>	
	<i>Salpicão de Vinhais</i>	
	<i>Sangureira de Barroso-Montalegre</i>	

Table 7.
List of products from Bísara breed.

7. Conclusion

Although we may know the Bísara breed a little better today, much is still to be done, especially in the development of production systems and environmental and husbandry strategies that may improve the effectiveness and quality of the Bísaro products.

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