ValCabri -Reconquering on-farm fattening of kids: improving value from the farmer to the consumer

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Abstract

In France, goat meat production is considered as goat milk co-product. ValCabri project aimed at improving kid meat value all along the production chain through the exploration of different levers. Work was conducted to identify the most appropriate genetics types to produce kid meat, and to optimize technical itineraries, including investigations in farms, focus groups regarding acceptability of kids fattening in farms and experimental tests. A part of the project was dedicated to the development of a kid meat proposal more appropriate to consumers needs, including new kids carcasses cuts and sensorial investigations. Finally, a project phase dealed with the economic aspects of kids fattening on farms, to propose production costs and various typical examples. All the results have been valued in different documents, available in open access on the website of the ValCabri project (https://idele.fr/valcabri/).

Keywords: kid, goat, meat, value, farming, fattening, farm.

1. Introduction

In France, goat meat production is considered to be a co-product of goat milk. It represents 6,100 tonnes of carcass equivalent, of which around 50% is kid meat (the rest being essentially cull goat meat) (Institut de l'Elevage, 2022). Many farmers find it difficult to get value from their animals, due to a lack of organisation for collecting and slaughtering kids, or a lack of interest. Production is also highly seasonal, and poorly adapted to consumer demand (Institut de l'Elevage, 2017; Patier, 2012). Technical, economic and social expectations are therefore high in this area.

The ValCabri project aimed to improve the value of kid meat for different kinds of stakeholders in the chain. Various ways of improving the profitability of kid production were studied, with a view to providing farmers with tools to boost fattening on their farms. The objectives of ValCabri can be broken down into three main areas:

1. optimise the technical itineraries for fattening kids and measure the impact on zootechnical performance, farmer's work, characteristics of the carcasses, nutritional and sensory qualities of the meat and workshop's economic results;
2. identify the genetic types best suited to producing kid meat in a dairy goat farm;
3. develop a product offering that meets consumer expectations, based on new carcass cuts, and check its sensory and economic acceptability.

The project was led by Institut de l'Élevage and carried out with professional partners (Fédération Nationale des Eleveurs de Chèvres, which initiated the project, and Capgènes) and teaching and research bodies (INRAE Unité Expérimentale P3R, EPLEFPA Olivier de Serres (Établissements Publics Locaux d'Enseignement et de Formation Professionnelle Agricoles, ferme expérimentale caprine du Pradel, 07170 Mirabel, France).

2. Identifying the most suitable genetic types for producing kid meat

2.1 Working methods used

In order to identify the most suitable genetic types for producing kid meat, three successive trials were carried out at the INRAE goat experimental farm in Bourges (Domaine de La Sapinière, 18390 Osmoy, France). The aim was to compare the growth performance, feed efficiency and carcass quality of 4 different genetic of goat types: purebred Alpine kids (control batch) and kids from a cross between the Alpine breed and a specialised meat breed (Boer) or a mixed breed (Rove and Pyrenean).

Each year, 120 kids were expected, 30 per genetic type. During the rearing phase, various measurements were done: milk consumption, weekly weighing of the kids and measurements. To assess the growth potential of each genetic type, 3 slaughter ages were tested: 30, 60 and 90 days. Following constraints linked to the weight of the kids at slaughter during the first two trials, the slaughter ages were modified for the 3rd round, with slaughter ages of 45, 65 and 85 days.

The carcasses were measured in quite a few ways: weighing, measurements (carcass and leg length, breech, back and shoulder widths), back fat thickness, pH and colour measured using the Minolta® CR400 Chromameter. In addition, assessment grids for conformation, fat cover and carcass colour have been formalised to characterise the carcass qualities of these kids.

2.2 Results

The first two years of the genetic types trial carried out at the INRAE experimental unit in Bourges did not produce the expected numbers of kids. The main lessons on the use of "meat" crosses were therefore obtained from the 3rd year of the trial. In this repetition, 36 purebred Alpine kids, 43 Alpine x Boer kids, 50 Alpine x Pyrenean kids and 40 Alpine x Rove kids were obtained. Birth weights were similar for pure Alpine kids and for Alpine x Boer and Alpine x Pyrenean cross-bred kids. The birth weights of Alpine x Rove cross-bred kids were lower on average and associated with a higher average number of kids per litter. The growth rates of the different batches varied according to the crosses; they were generally higher for Alpine x Boer kids and lower for Alpine x Pyrenean kids, with those of pure Alpine and Alpine x Rove kids being intermediate (Figure 1).

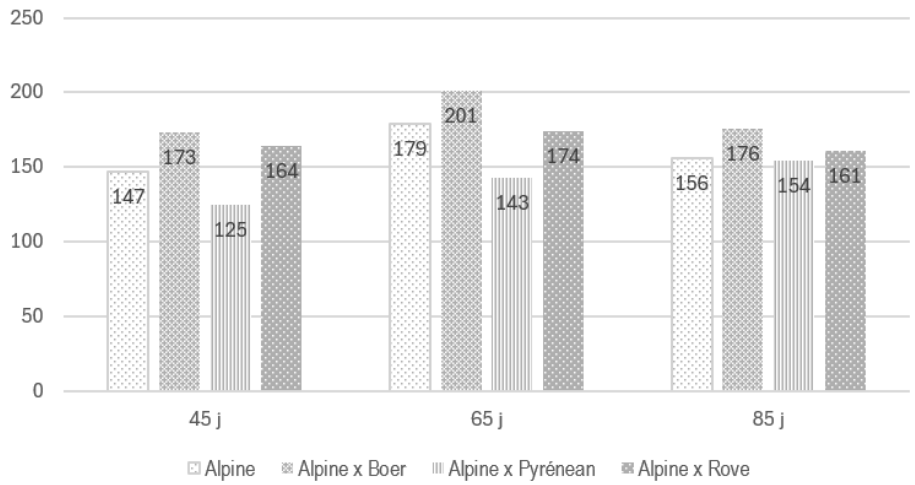

Figure 1: Average daily gain (ADG) of kids for different genetic types and slaughter ages.

At carcass level, the weight logically increased between kids slaughtered at 45 days (5.9 kg) and those slaughtered at 65 days (8.0 kg), but then remained stable for kids slaughtered at 85 days (7.7 kg). This stability between slaughter at 65 and 85 days is linked to the weaning of the kids, which had an impact on their growth and carcass yield (-7% on average, due to the increase in digestive content). For the different ages at slaughter, the carcasses of Alpine x Boer crosses were the heaviest (9 kg at 65 days)

while those of Alpine x Pyrenean crosses were the lightest (6.7 kg at 65 days), with those of pure Alpines (8.2 kg at 65 days) and Alpine x Rove crosses (8.1 kg at 65 days) being intermediate. The same was true for the conformation and measurements of the carcasses. Logically, the meat became more pigmented over time, resulting in an increase in the visual colour score and in instrumental colour measurements, with a decrease in luminance and an increase in the red index.

Milk consumption also varied according to crossbreed, and followed the same order as growth. Over the period 0-45 days, average milk consumption per kid was 1.47 l/d for Alpine x Boer crosses, 1.38 l/d for pure Alpines, 1.33 l/d for Alpine x Rove crosses and 1.08 l/d for Alpine x Pyrenean crosses. Over the 45-65 days period, the same trend was observed, with Alpine x Pyrenean crosses consuming less. Alpine x Rove crosses consumed more than purebred Alpines over this second period.

Solid feed consumption between 0 and 45 days was negligible overall. Over the period 45-65 days, Alpine x Rove and Alpine x Boer crosses consumed around 130 g of hay/day/kid, and pure Alpine and Alpine x Pyrenean crosses around 90 g/day/kid. However, pure Alpine kids consumed far more concentrates (70 g/day/kid) than crossbred kids (46 g/day for Alpine x Boer crosses, 34 g/day for Alpine x Rove crosses and 14 g/day for Alpine x Pyrenean crosses).

Average daily gains (ADGs) were in line with feed conversion rates. Alpine x Boer kids showed higher growth rates, but also higher feed conversion ratios. Conversely, the Alpine x Pyrenean kids had lower ADGs and consumption indices. The results for pure Alpine and Alpine x Rove kids were intermediate.

In the 3rd trial, only kids slaughtered at 85 days were weaned at around 65 days. This weaning had a major impact on the subsequent growth performance of the kids, whatever their genetic type: the carcass weights of the 85-day-old kids were broadly equivalent to those of the 65-day-old kids. In view of these results, weaning seems to have a particularly strong impact on kids and needs to be well anticipated before slaughter. Further work on the benefits of weaning and its implementation as well as other results seems necessary.

3. Optimising technical initeraries for fattening kids

3.1 Working methods used

Three trials were set up at the Pradel Experimental Farm (EPLEFPA Oliviers de Serres). They focused on i) the impact of the mothers' diet at the end of gestation on the growth kinetics of newborn kids, ii) the impact of the type of milk replacer on the production of light kids and iii) the optimisation of the technical itinerary for fattening cross-bred kids.

3.1.1 Experimental trial on feeding dams at the end of gestation and impact on kids

In this trial, 2 levels of protein intake (high and low) during the last 15 days before farrowing were tested to assess the impact on the kids. The trial was conducted on 2 batches of 46 pregnant dams fed Italian ryegrass + lucerne hay and 600g of concentrate. In the end, the protein coverage level of the 'low' batch was 140% compared with 160% for the 'high' batch, i.e. a difference of 40 g of digestive protein in the intestine between the batches. Batches of kids from the 2 conditions were formed and each individual received colostrum from its mother. The kids were then fattened using a standard itinerary based on the recommendations.

Of the 146 kids born to 92 dams, 44 males were monitored and their characteristics recorded until slaughter at an average of 24 days. The following measurements were taken on the dams at farrowing and for around 10 weeks after farrowing: quantity, Milk Fat Content) and Milk Protein Content, quantity and IgG (immunoglobulin G) rate of the colostrum and Body Condition Score (BCS). The zootechnical performances of the kids were measured (live weight, growth, consumption index), as well as their health status, the state of their fat and muscle reserves *in vivo* (barymetric measurements) and their carcass quality (weight, measurements, colour and pH and assessments of conformation and fat cover). The

nutritional characterisation of the meat from each batch was carried out by analysing the main nutrients of interest in the meat (proteins, lipids, fatty acid composition, iron, zinc, selenium, vitamin B12), and the sensory qualities of the meat was assessed from each batch, through sequential monadic tastings by expert juries.

3.1.2 Experimental trial on the effect of the nature of the milk replacer

In this trial, after the colostrum period, 3 breastfeeding foods were compared: raw breast milk and 2 reconstituted milks, one with 0% skimmed milk powder (SMP), the other with 65% SMP. These 2 foods were comparable on their dietary values (digestible proteins, metabolizable energy), and were both enriched with omega-3 fatty acids. The concentrations of the reconstituted milks were identical (150 g/L of water, i.e. 130 g/L of drink), and each batch was attached to a milk feeder to measure their respective daily consumption. The mother's milk was distributed 3 times a day. Sixty kids and 91 replacement kids were divided into 3 batches. Only male kids were slaughtered at 24 days of age on average. The females were followed until weaning at an average age of 55 days.

Zootechnical performances of the kids were measured, as well as state of fat and muscle reserves *in vivo*, carcass quality, economic benefits of the practices (energy consumption, feed costs, etc.) and nutritional and sensory qualities of the meat.

3.1.3 Experimental trial on optimising the technical itinerary for fattening cross-bred kids

In this trial, it was decided to compare purebred Alpine kids with kids from a cross with an Alpine goat and a Boer billy-goat. A total of 53 cross-bred kids and 54 Alpine kids were obtained. Only the males (Alpine and crossbred) and crossbred females were slaughtered at 50 days of age. The kids were fed a 0% SMP milk replacer. The two batches were physically separated in order to measure milk consumption by batch. Zootechnical performances of the kids were measured, as well as state of fat and muscle reserves *in vivo*, carcass quality and nutritional and sensory qualities of the meat.

3.2 Results

3.2.1 Experimental trial on feeding dams at the end of gestation and impact on kids

All the measurements carried out showed no difference when the ration was supplemented with protein in this value range: the results of the batches were similar, regarding milk production (quantity, Fat Content and Protein Content), growth results of the kids, weight and quality of their carcasses (measurements, conformation, fat cover, colour) and nutritional and sensory qualities of their meat. The experiment enabled data to be acquired on the quantity of colostrum (on average 30 g/L of immunoglobulin G for a quantity of around 1.3 L per goat). The kids were slaughtered at an average age of 25 days and a live weight of 10.7 kg (Figure 2). Carcasses weighed an average of 6.2 kg, giving a yield of around 55%-60%.

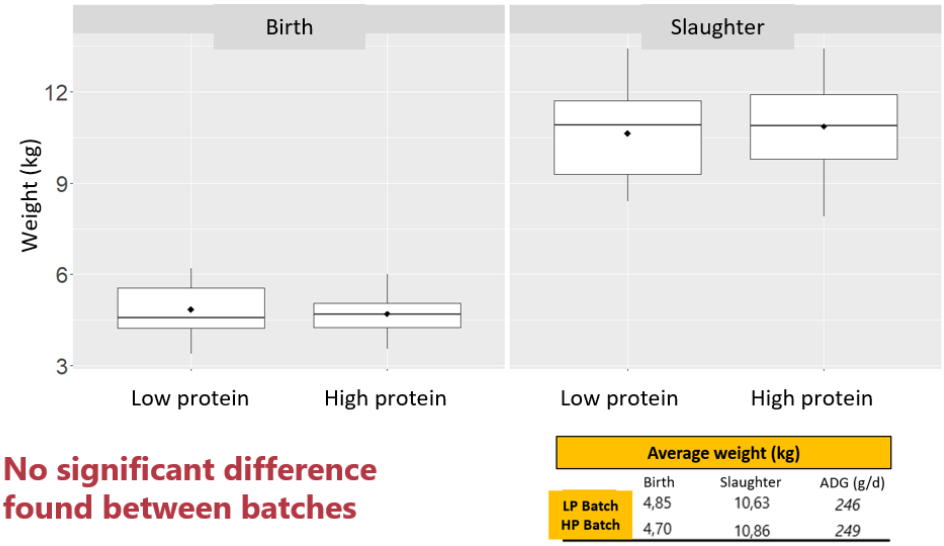

Figure 2: Birth weight and slaughter weight (kg) of kids from dams on low protein (LP) and high protein (HP) diets.

Nutritional analyses showed that in this trial, kid meat was very lean, with a good protein content, both in terms of quantity and quality. It is also a source of vitamin B12, iron and zinc that are easily assimilated by humans. Sensory analysis of the centre of the leg of kid by a panel of experts showed that in this trial, the kid meat had no major taste defects: the taste and smell were not very pronounced.

3.2.2 Experimental trial on the effect of the nature of the milk replacer

In this trial, 3 batches of 21, 18 and 21 kids were monitored as well as 2 batches of 45 kids. Male kids were slaughtered at 24 days of age on average. The average birth weight of the male kids was 4.7 kg. Growth was similar for all three batches, with an average birth-to-slaughter ADG of 210 g/day (Figure 3). The kids were slaughtered at 9.8 kg live weight and 5.6 kg carcass weight. No significant differences in carcass weight, conformation or measurements were observed between the 3 batches. However, in this trial, carcasses of the kids reared on mother's milk were slightly leaner and lighter in colour than those of the other 2 batches.

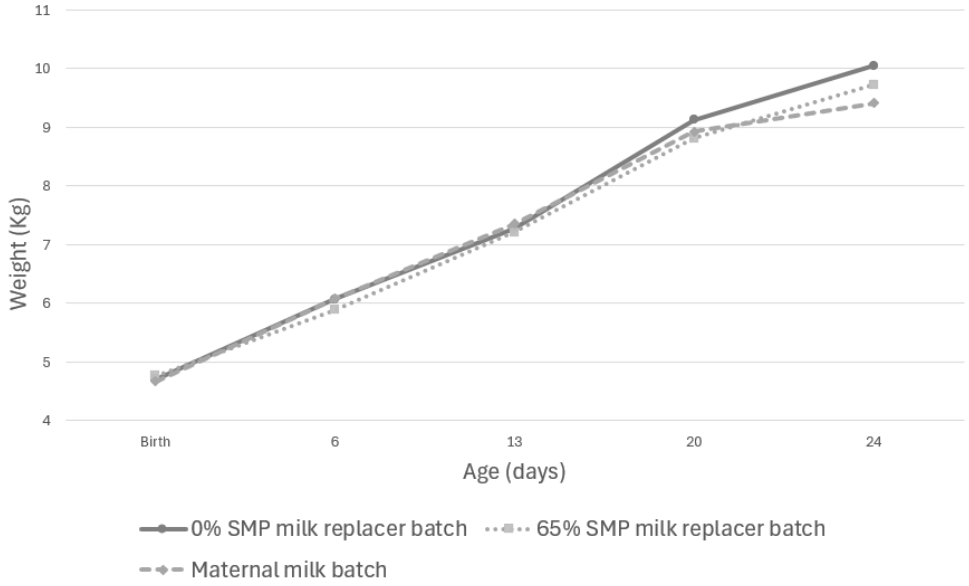

Figure 3: Changes in live weight of male kids in the three batches (maternal milk, 0% SMP milk replacer, 65% SMP milk replacer).

Kids fed with milk replacer at 0% SMP had a higher consumption than those fed with milk at 65% SMP (7.8 kg vs. 6.2 kg of powder per kid), but the cost of feeding was lower (14.5 euros vs. 17 euros per kid, i.e. a difference of 2 to 3 euros depending on the price per tonne of the products, in the context of 2020 prices). Regarding mother's milk, kids consumed a total of 37.7 litres, or 1.5 litres per day on average. The cost of feeding kids' mother's milk varies according to the proportion of post-colostral milk provided. In this trial, where only part of the milk supplied was post-colostral milk, the cost of feeding varied from 12.5 euros per kid if the milk was delivered to the cooperative, to 35 euros per kid if the milk was processed on the farm into Picodon PDO (Protected Designation of Origin cheese).

Sensory qualities of the meat analysed in laboratory by a panel of experts (odour, flavour, tenderness, juiciness) did not differ between the three feeding methods. Regarding nutritional qualities, no differences were observed between the batches, except for vitamin B12: the meat from kids fed 0% SMP feed had higher levels (0.9 µg/100 g) than that from the other 2 batches (0.5 µg/100 g), in line with the vitamin B12 supplementation in this feed.

The omega 6/omega 3 ratios reached a value of 11 in the batches fed milk powder enriched with omega 3. A similar ratio was observed in the batch fattened with breast milk where no omega 3 was added. However, the alfalfa and rapeseed concentrate fed to the goats are natural sources of omega-3 and may explain this result. The ratio recommended by nutritionists in a balanced diet is 5.

3.2.3 Experimental trial on optimising the technical itinerary for fattening crossbred kids

At birth, Alpine x Boer crossbred kids were significantly heavier than purebred Alpine kids: on average, 5.1 kg and 4.4 kg respectively for Alpine x Boer males and females, compared with 4.7 kg and 4.2 kg for purebred Alpines. However, there was no significant difference in growth between the two genetic types, and the curves remained very linear (Figure 4).

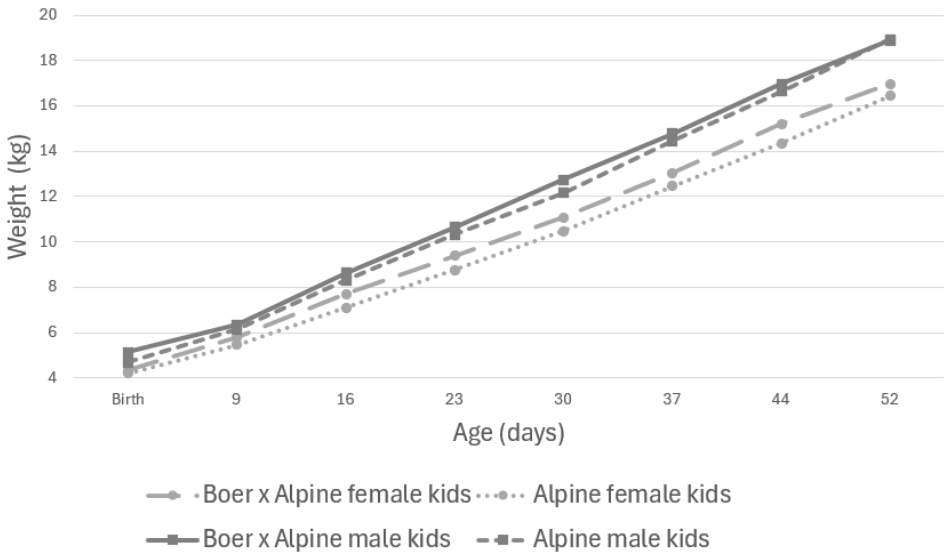

Figure 4: Evolution of the live weight of male and female kids of the pure Alpine breed or from a cross between the Alpine and Boer breeds.

Birth-to-slaughter ADGs were 271 g/d and 281 g/d respectively for Alpine x Boer and purebred Alpine males, and 252 g/d and 238 g/d for females. The higher body condition scores (BCS) for the crossbred kids reflected improved carcass conformation and/or more advanced fat cover. Morphological differences were visible between the two batches: purebred Alpine kids were long and tall, with slender limbs; Alpine x Boer crosses were shorter-legged, with stronger limbs. Regarding milk consumption, the consumption index differed little between the 2 batches (1.39 for the batch of crossbred kids compared with 1.37 for

the batch of Alpine kids). The cost of solid feed was the same for the 2 batches (€35.70 for the crossbred kids compared with €34.70 for the Alpine kids).

There were no significant differences between batches in terms of carcass weight or slaughter yield. Carcasses of the Alpine x Boer crosses were significantly more compact than those of the Alpines (-3.3 cm) and their legs significantly shorter (-1.5 cm). They were also better conformed. There was no significant difference between the 2 batches in terms of carcass colour. Overall, the meat was more pigmented than that from kids aged 25-30 days, in line with the development of pigmentation with the age of the kids. As for the nutritional qualities of the meat, dissection of a whole chop showed no difference between the 2 batches, with around 60% muscle, 27% bone and 12% fat. The nutritional composition of the chop was not significantly different between the batches. The iron content of these 50-day-old kids was much higher than that of kids slaughtered at around 25 days in the two previous trials. There was no difference in sensory quality between the meat from the 2 batches.

In the light of these results, there seems little point in carrying out this type of cross with a slaughter age of 50 days on farms where the growth of pure-bred kids is generally good.

4. Overview of existing practices and acceptability of on-farm fattening of kids

4.1 Working methods used

The inventory of practices was based on field surveys of farmers fattening kids on their farms. The survey questionnaire was used to gather information on work organisation and time, equipment and buildings, fattening methods and duration, depending on the type of kids produced, marketing channels, etc. These surveys were carried out with 57 farmers from the five main goat regions in France: Nouvelle-Aquitaine / Pays de la Loire / Bretagne (20 farmers), Centre-Val de Loire (5), Occitanie (6), Auvergne-Rhône-Alpes (19) and Provence-Alpes-Côte d'Azur (7). They were carried out by INOSYS breeding network technicians.

The work on the acceptability of on-farm fattening of kids was carried out through *focus groups* involving around ten farmers per group. These meetings provided an opportunity to assess the acceptability of on-farm fattening to farmers, identify limiting factors and prioritise the issues to be addressed. Nine *focus groups* (as well as 2 workshops as part of the South East farmhouse cheese meetings) were held in different regions, corresponding to the major production areas surveyed in the inventory of practices. They were set up and run by the Institut de l'Elevage and the FNEC, in collaboration with a development structure in each region (Chambre d'Agriculture des Deux-Sèvres, Chambre Régionale d'Agriculture Centre-Val de Loire, Groupement d'Intérêt Economique Élevage Occitanie, Plateforme d'Expérimentation et de Progrès Caprin Rhône-Alpes, Maison Régional de l'Elevage Provence-Alpes-Côte d'Azur, Seenovia).

4.2 Results

According to the 57 farm surveys carried out, kids are fattened on all types and sizes of farm. The surveys showed the great diversity of this activity in terms of products, marketing channels and rearing practices. The results have enabled us to identify the different types of kid being fattened: light kids, mainly in the west and for long distribution channels, heavy kids, mainly in the south-east and for short distribution channels, and very heavy kids for farm cheesemakers for direct sale.

The management of male and female kids is identical on 60% of farms. On the remaining 40% of farms, the differences concern the thermisation of the milk, which is only carried out for female kids, and/or the use of unmarketable milk only for male kids. When male kids are born, half of the farmers separate them very quickly from their mothers, as they do for female kids, for health reasons. The others remove them between 12 and 48 hours after birth, or even later. Colostrum management varies: just under half the farmers leave the male kids under the mothers. The others distribute colostrum to them in various ways:

type of colostrum (maternal or mixed), quantity distributed, number of distributions per day and number of days of distribution, etc. Nearly 30% of farmers heat the colostrum. The use of milk powder remains the most widespread breastfeeding method (37% of farms). Non-marketable milk is used on 27% of farms, 15% of farms use marketable goat's milk, and 20% leave the kids with their mothers. The latter two methods are mainly used by farm-based cheese producers who produce heavy and very heavy kids.

This diversity of practices, ranging from simplification to much more time-consuming management, probably has an impact on the technical results (mortality, health aspects, ADG, etc.) of these fattening farms. It underlines the need to formalise technical itineraries that are efficient from a technical point of view, yet feasible in practice for farmers.

The farmers in the different *focus groups* had very different types of farm; they can be categorised into three main types: i) Farmers who fatten their kids and market them through long distribution channels. They are convinced of the benefits of fattening and would like to discuss their practices and work organisation; ii) Farmers who fatten their kids and market them through short distribution channels. They are highly motivated, express concerns about the logistical aspects, and do not always calculate their cost price; iii) Farmers who do not fatten their kids. Their main obstacle is working time, and they took part in the *focus groups* because of concerns about the economic situation or the future of the fattener who currently collects their 8-day-old kids.

These meetings highlighted the various reasons for fattening kids on the farm, which are common to all types of farming: get the most for the product (compared with an 8-day-old kid), or the milk that cannot be marketed, or other advantages: availability of buildings and labour, proximity to the abattoir, etc. Another reason may be to repay the cost of the "female kids" building, and/or to achieve enough kids to run the milk feeder. In addition, there are a number of reasons that are specific to farmhouse cheese producers, such as diversifying the range and responding to customer demand.

The obstacles identified at these meetings relate to 4 main issues. Regarding marketing, the obstacles centred on the absence of a local abattoir, the difficulties of logistics in short circuits, the doubts about the existence of a market for kids or about the profitability of this workshop. As far as technical aspects are concerned, the obstacles are the lack of space in the buildings, the existence of health risks, and the lack of technical references. Finally, the lack of equipment and manpower, and the fact that it represents too much work in short circuits, were also cited as obstacles.

Various expectations were also expressed by the farmers, in connection with these identified obstacles, and in particular with regard to marketing (slaughtering solutions, sustainability of local cutting and processing plants, raising the profile of kid meat, etc.), profitability (better knowledge of the profitability of the workshop and its main factors, decision-making tools and suggestions for improving profitability, etc.), technical skills (diversity of fattening methods, use of post-colostral milk, recommendations for buildings, etc.), work (skilled labour, sharing of experience, etc.).

5. Develop a range of new cuts of kid carcass to meet consumer expectations, and test their sensory and economic acceptability.

5.1 Working methods used

5.1.1 The development of new cuts of kid carcass

New cuts of kid carcass and new meat preparations were considered, based on the experiences of various organisations and the literature (Normand *et al*, 2012). It was guided by the size of the portion (and therefore its price), the reduction of waste (bone/fat) on the plate and cooking time. The aim was to offer kid meat easy and quick to cook, and better suited to the expectations of consumers, who are increasingly looking for ready-to-eat prepared products. These new cuts were used by butchers from the Institut de l'Elevage on kid meat produced during the project's experimental trials. More than 250 kids were cut to

obtain references on cutting yields and the working time required. These cuts were presented and discussed on quite a few occasions, in particular with professionals in the sector, resulting in 2 proposed carcass cuts: a simple cut and an elaborate one.

5.1.2 The shelf life of new cuts of kid meat

The meats produced during the 2nd and 3rd years of trials conducted at the INRAE Experimental Unit in Bourges were cut according to the specifications developed in the previous section. Their residual lifespan was then assessed by Products Analyses and Technology Laboratoy in the Institut de l'Elevage. In order to capture individual variability, which is particularly important in terms of shelf life, this work was carried out with 7 kids per batch, for 8 batches (4 genetic types x 2 slaughter ages). Two packaging methods (vacuum and modified atmosphere packaging) and 3 shelf lives were tested for 2 types of products: bone-in pieces for slow cooking and boneless leg steaks of kid. A total of 2,688 meat trays were assessed (colour of top, colour of bottom, quantity of exudate, odour on opening, etc.) by a panel of 3 experts.

5.1.3 Consumers'acceptability of new goat cuts and possible added for the sector

Three surveys, each involving 120 'naïve' consumers, were carried out in 3 major consumer cities (Lille, Poitiers/Melle and Lyon). Each survey consisted of a blind hedonic sensory analysis of raw and then cooked cuts of kid, supplemented by an economic approach to willingness to pay using non-hypothetical measures. Willingness to pay enables to place consumers in a real purchasing situation: depending on their response, they will be led to actually buy the product sold. In a final stage, consumers were asked to complete a questionnaire covering socio-demographic aspects, their purchasing and cooking habits, and their expectations and fears about kid meat. The cuts assessed visually ranged from current cuts (leg and forequarter from light kids), through simpler cuts (leg, shoulder and slow cooking pieces from heavy kids), to very elaborate cuts (boneless roasts in the leg and in the forequarter, and minute slow cooking pieces from heavy kids). It was decided to assess the meat from 3 types of kid for eating quality: a light kid (5.3 kg carcass on average), a heavy kid from a pure Alpine breed (10.9 kg carcass) and a heavy kid from a cross between the Alpine and Boer breeds (10.6 kg carcass). The meat came from trials carried out during the project and was cut according to the specifications drawn up in the first part of the project.

5.2 Results

5.2.1 The development of new cuts of kid carcass

Two more or less elaborate cuts of kid carcass were proposed: a relatively simple cut, leading to a yield of around 83% marketable meat in the carcass (excluding offal) and a more elaborate cut, leading to a yield of around 67% marketable meat in the carcass (excluding offal).

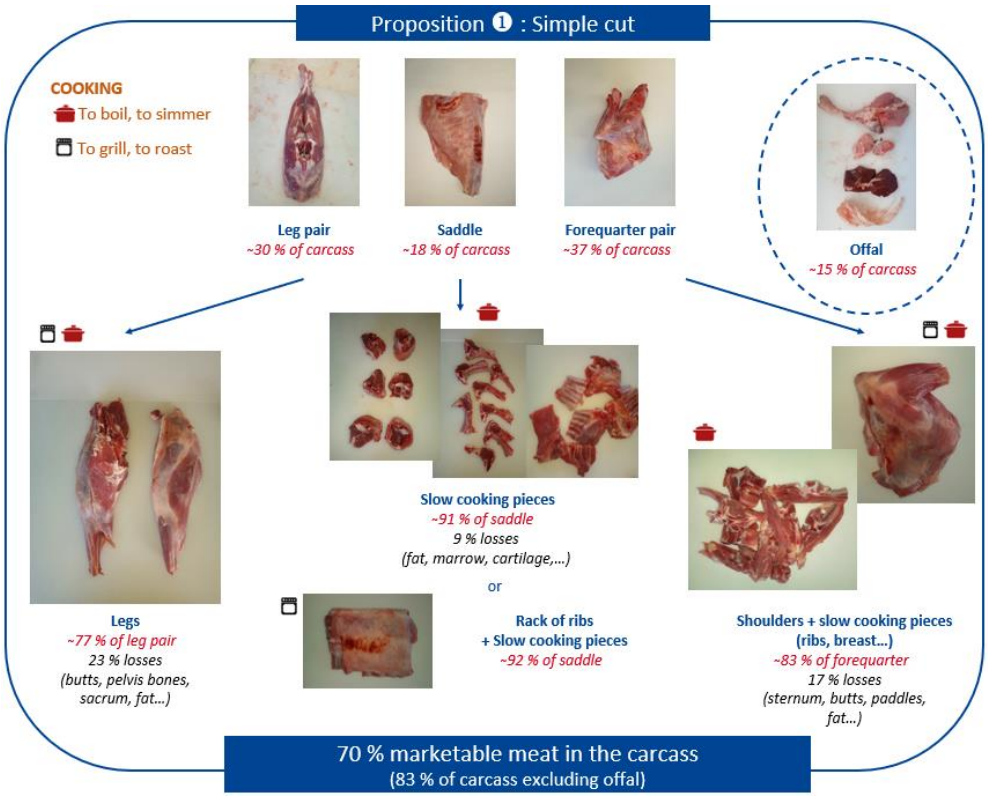

Figure 5: Proposed simple cut of kid carcass.

The simple cut (Figure 5) aims to preserve the cutting yield while reducing waste for the consumer. The carcass is cut into 3 parts (leg pair, saddle and forequarter pair) and the leg pair is presented in the form of 2 legs, after removal of the butts, sacrum and pelvic bones. The saddle can be entirely proposed for a stew. The shoulders are separated from the forequarter pair to be sold as roasts or stews after removal of the butts and paddles. The rest of the forequarter pair is then diced for a stew.

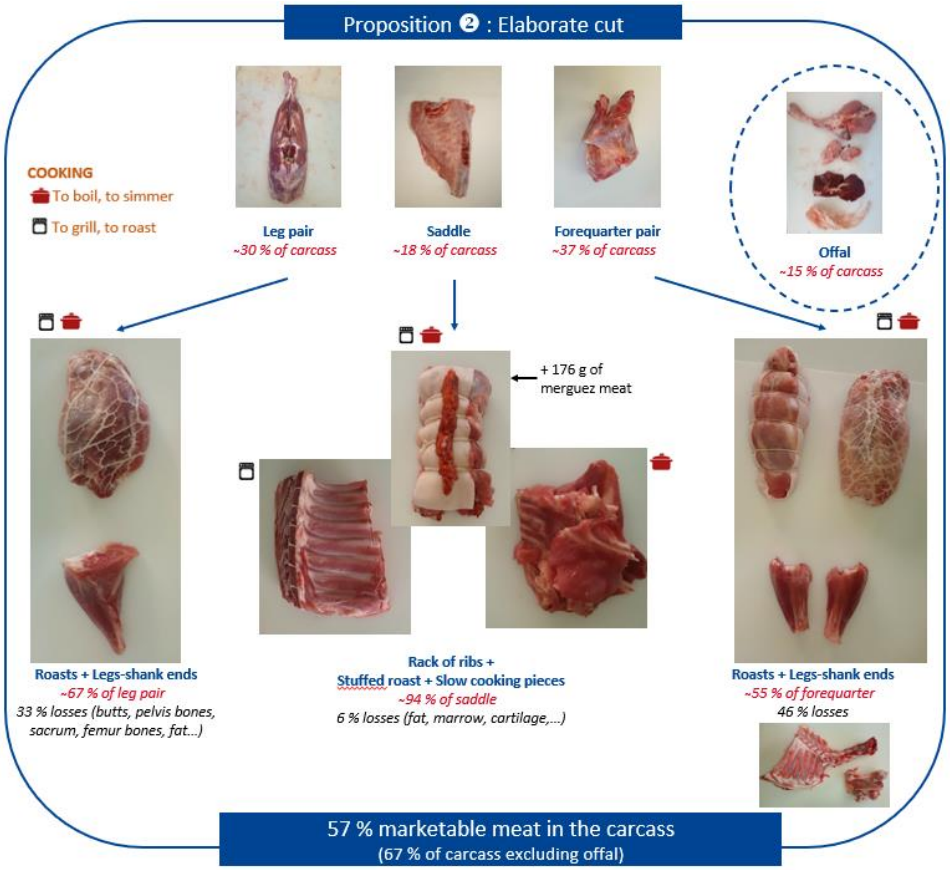

Figure 6: Proposed elaborate cut of kid carcass.

The aim of the elaborate cut (Figure 6) is to provide the consumer with products easy to prepare and serve, with as little waste as possible. The leg pair is marketed as 2 roasts (boneless) and 2 legs-shank ends. The loin is boned in one piece. The bone is then replaced by a stuffing to produce a stuffed roast. The first and second rack of ribs are kept for grilling, with the top of the ribs cut into slow-cooking pieces. The forequarter pair is boned in one piece to produce 2 boneless roasts and 2 legs-shank ends.

In both cases, the marketing prices of the products will have to take into account the reductions in cutting yield and higher cutting time. Simulations were carried out in this respect.

5.2.2 The shelf life of new cuts of kid meat

Slices of boneless leg of kid and bone-in slow-cooking pieces were packaged in a high-oxygen modified atmosphere on the one hand and under vacuum on the other, during 2 trials carried out over 2 consecutive years. In the end, 2,688 packaged products from 112 kids were assessed after conservation by the panel of experts.

For modified atmosphere packaging, these tests showed that the colour of bones, the fat and the amount of exudate remained stable during storage. On the other hand, a change in colour was observed, more intense on the leg than on the slow-cooking pieces. This was the main reason why the leg was not eaten. A change in smell was also observed, more intense in the stir-fry than in the leg, and this was the main reason for not eating the stir-fry. According to these results, the shelf life under modified atmosphere would be 6 days. No effect of breed or sex on shelf life was observed.

As far as vacuum packaging is concerned, these tests showed that the colour of the meat, bones and fat remained stable during storage. An exudate appeared, slightly more intense on the slow-cooking pieces than on the leg, but this had little effect on the decision to buy. There was also a change in smell during storage. It was slightly more intense on the slow-cooking pieces than on the leg. This is the main reason why slow-cooking pieces were not eaten from D18. Discolouration occurred fairly late. It was more intense

in the leg of kid but did not seem to penalise the slow-cooking pieces very much. According to these results, the vacuum-packed meat could be kept for 16 days. No effect of breed or sex on shelf life was observed.

These results relate only to the sensory aspects of product preservation, with validation of the microbiological shelf life of products still to be carried out in the context of each individual case.

5.2.3 Consumers'acceptability of new goat cuts and possible added value for the sector

The surveys were carried out in 3 areas: Lyon, Poitiers/Melle and Lille. The protocol was strictly identical for each session. In terms of results, half of the panel had already eaten kid meat before the test. For the other ones, the main reasons were lack of knowledge about this meat (for 76% of these consumers) and difficulty in obtaining supplies (for 60%).

In terms of overall satisfaction with the visual assessment of the product, the least popular product was the forequarter, and the most popular was the leg of kid. Some products were very popular (leg and shoulder), with very high levels of satisfaction. Satisfaction with roasts in the leg or shoulder was slightly lower than with more traditional bone-in products. This result raises the question of the value of going to such a high level of product development. At best, half of consumers were satisfied with forequarter and to a lesser extend with leg (Figure 7).

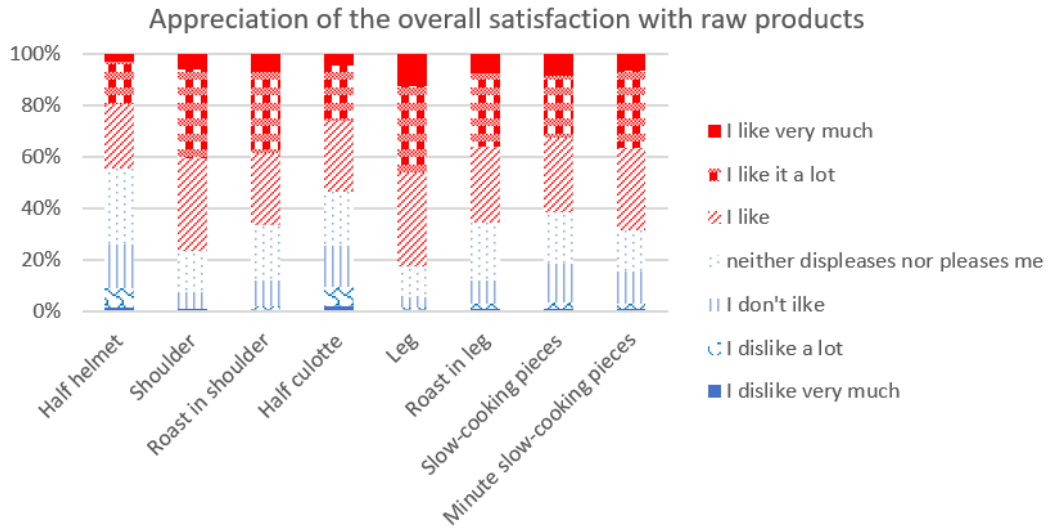

Figure 7: Overall satisfaction with raw products.

Regarding intentions to re-consume products, for shoulder roasts, levels were around 75% for heavy kids, with a clear gap with light kids (60%). For the legs, the levels were more like 70%, slightly below the shoulders of the heavy kids, with little difference between the 3 types of kid. With two thirds to three quarters of consumers willing to eat any of the products again, kid meat was generally very well perceived by consumers, from a sensory point of view (Figure 8).

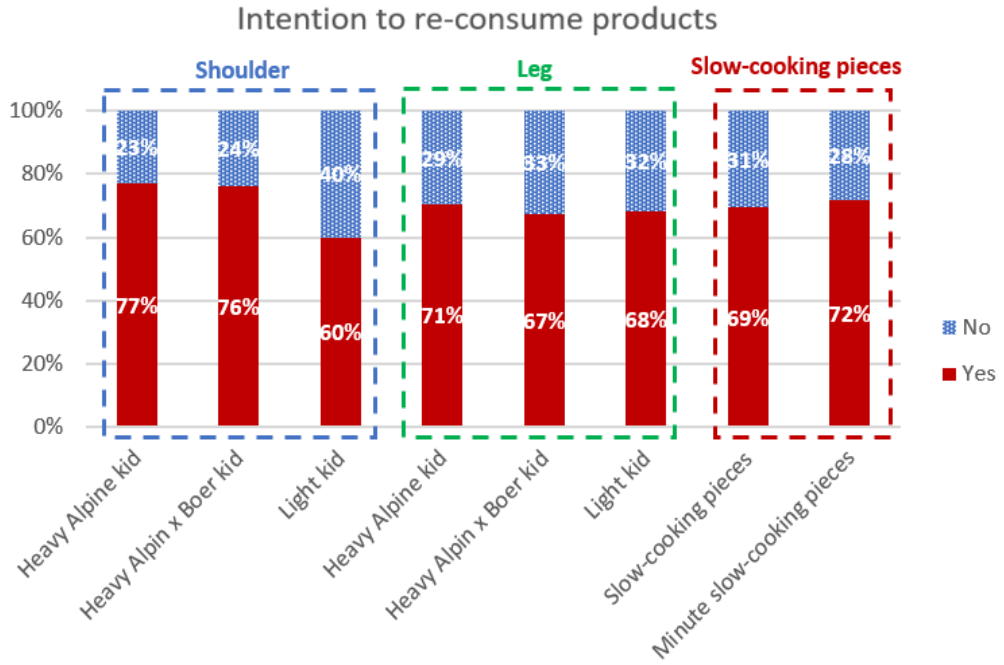

Figure 8: Intention to re-consume cooked products.

In terms of willingness to pay (WTP), it should be noted that at the time of the test, half a carcass was being sold in modified atmosphere boxes at around €12 to €14/kg.

Based on WTP's measurements, the price paid by consumers for products marketed in boxes (half-forequarter and half-leg) was €13.5/kg on average. For shoulder, consumers agreed to an increase of 12% compared to the box, 18% for leg, 20% for shoulder roast, 15% for leg roast, 2% for slow-cooking pieces and 9% for minute slow-cooking pieces. Overall, these prices are low to very low. In view of these results, consumers do not seem to be aware of the level of preparation of the products compared to an unprepared product (for example, a roast in the leg compared to a leg).

The results of the willingness-to-pay survey were relatively disappointing: the price increase agreed by consumers did not cover the yield losses and labour time required to implement the new cuts. Consumer information and awareness campaigns on these aspects would therefore appear to be necessary. Furthermore, the methodology used in this study to determine willingness to pay does not appear to be adapted to the context of a 'new product' for which the consumer has no price reference.

6. The economic benefits of adding value to kids on the farm

6.1 Working methods used

The first part of this study focused on calculating the income generated by the kid fattening workshop. The economic results generated by fattening kids on farms were quantified, with a distinction being made between farmers who sold their animals on long or on short distribution channels. Thirty farms, identified in the INOSYS-Réseaux d'élevage database, were surveyed by INOSYS-Réseaux d'élevage engineers, to calculate the profitability of the fattening workshop, based on a cost-of-production approach. The data collected during these surveys was used to produce case studies focusing on the "kid" workshop.

In the second part, economic simulations were carried out on the typical cases developed in the previous part, varying in the mortality criteria and the cost of milk powder in particular, to be able to qualify the conclusions. The various *focus groups* set up for the work on the acceptability of fattening kids on farms were brought together again to discuss the results of the simulations, using the same moderation system.

6.2 Results

A production cost has been calculated for kids sold in the long chain. In this case, the kids are fattened by the farmer, sent to the abattoir and the abattoir takes care of marketing. 12 farmers surveyed fall into this group. The average selling price for live kids was €30.93 (€3.15/kg live). The variability of this price between farmers is linked to the selling period and the farmer's negotiating skills. Total non-labour costs (milk powder, veterinary costs, identification, water, electricity, maintenance and repairs, depreciation of buildings and equipment, etc.) amount to €16.63 per kid, with the highest cost being milk powder (€9.80). The variability in costs can be explained by a mortality rate that varies from farm to farm, and a greater or lesser consumption of milk powder. Working hours were recorded according to farmers' statements. The average observed was 40 minutes per kid, with a fair degree of variability. In this group, the farmer is left with €14.30 per head to pay for his work. The cost price corresponds to the price at which the kid 'should' be paid for the farmer to earn 2 SMIC (SMIC is the legal minimum wage). In this group, the cost price per kid is €30.52. This means that more than half the farmers in this group manage to earn more than 2 SMIC. The variability observed is linked firstly to the greater or lesser use of post-colostral milk and the mortality rate, and secondly to the sale period.

A calculation of the cost of production was also carried out for 17 farmers who fatten their animals through short distribution channels. In this group, the types of animals fattened are varied. There is also a wide variety of marketing channels. Most of the farmers in this group are farmhouse cheesemakers. Herd sizes are smaller than in the previous group. The average age of kids at sale is over 2 months. The average selling price is €118 per kid, but this masks considerable variability between marketing channels and within each marketing channel (from €12.87/kg to €16.54/kg of carcass for package sales, for example). Farming costs (including labour) are higher than in the previous group, reflecting the smaller number of kids fattened. The use of marketable goat's milk by some farmers also increases the cost of rearing. In addition to these rearing costs, there are the costs of processing and marketing and the associated labour. These costs, which are specific to direct sales, are often high and vary according to the distance to the abattoir and cutting plant. In this group, a kid would have to be sold for an average of €153, or €17.39/kg of carcass, for the farmer to earn 2 SMIC. This means that the majority of farmers in this group do not earn this level of income.

Based on all the information gathered, five case studies were produced. They illustrate different types of farming (delivery or cheese-making, heavy or light kids, long or short chains, etc.).

Based on these case studies, economic simulations have been carried out. They are integrated into each case study, and show the greater or lesser variation in income depending on various factors, such as the mortality rate, the price of milk powder and the selling price of kids. Given the significant variations caused by the Covid pandemic19, the simulations were carried out using 2019 data on the one hand, and updating and presenting 2021 data on the other. For example, in the first typical case, which concerns a farmer who delivers and fattens 100% of his kids into light kids, which he feeds with milk replacer and markets in the long chain, for 2019, a 5-point impact on the mortality rate leads to an 8.4% change in income for this workshop, i.e. €367 more or less for the farmer. The same simulation, updated to 2021 figures, would result in a 12.8% change in income for this workshop, i.e. €414 more or less for the farmer.

7. Conclusion

The ValCabri project produced a set of data and technical references on various topics relating to on-farm kid fattening. All these results were used to produce a range of deliverables: summary brochures, technical fact sheets, videos and webinars, all of which are freely available on the project's dedicated website https://idele.fr/valcabri/, and have been widely distributed to all players in the industry at various events.

These results provide technical information on an area where references have been limited to date. The ValCabri project also demonstrated the existence of strong expectations on the part of players in the field,

particularly regarding the provision of tools and technical references. As a result, during the project, various interventions were carried out to disseminate and publicise these results in the regions. A new project, called CABRI+, focusing on supporting local players in the development of on-farm fattening of kids, is due to start in 2024; it will enable the ValCabri achievements to be rolled out across the regions.

Ethics

The authors declare that the experiments were carried out in compliance with the applicable national regulations.

Declaration on the availability of data and models

The data supporting the results presented in this article is available on request from the author of the article.

Declaration on Generative Artificial Intelligence and Artificial Intelligence Assisted Technologies in the Drafting Process.

The authors used artificial intelligence in the translation process from French to English.

Authors' contributions

All the authors have read and approved the final manuscript.

Declaration of interest

The authors declare that they do not work for, advise, own shares in, or receive funds from any organisation that could benefit from this article, and declare no affiliation other than those listed at the beginning of the article.

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