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Increasing the rate of genetic improvement in dairy goats through juvenile selection

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Abstract

Traditional selection schemes in dairy goats are based on progeny testing of bucks based on the performance of their daughters. An alternative juvenile selection scheme is proposed in which selection is entirely based on young bucks and does based on evaluation of their parents. The bucks are replaced every year, a larger number of bucks are used and there are fewer progeny per buck. This helps in reducing the generation interval and increasing selection intensity, with some loss in accuracy in breeding value estimations of individual bucks. This selection scheme is applied to dairy goat populations in Canada. New web based evaluation and selection tools have been developed that allow participating producers to enter new information and instantly identify top selection candidates based on the genetic evaluations of their parents. It is estimated that selection using such a juvenile scheme will lead to an increase of 30 kg milk/year. This will lead to faster genetic improvement compared to conventional progeny tests.

Keywords: juvenile selection, dairy goats, progeny test, genetic progress, accuracy, selection intensity, generation interval
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Introduction

Genetic improvement programs in dairy goats are designed to increase milk yield while maintaining or increasing milk solids and body conformation. These programs are traditionally based on progeny testing schemes and have resulted in substantial genetic improvements. However, there are opportunities for further improvement. The most important factors determining the rate of genetic improvement are selection intensity and generation interval (Cameron, 1997). An optimal selection scheme should make effective use of available tools for increasing the rate of genetic progress. The selection scheme is the key to the success of a nucleus program and affects profitability of producers for many years to come. A more effective scheme does not necessarily involve increased investments. It has been shown that practical changes to existing selection schemes could double the rate of genetic improvement (Mathur, 1999).

Conventional progeny tests

The conventional breeding schemes for dairy animals based on progeny testing of sires can theoretically produce gains of about 2% of the breed average milk yield per year, where in practice, the gains have tended to be in the 1 to 1.5% range (Smith, 1984). The success of these programs is often limited by population size, and the ability to test a large number of sires. This is particularly true of goat populations in most countries, where relatively few goats are on comprehensive performance recording programs. An exception to this generalization is in France, where approximately 156,000 Alpine and 134,000 Saanen goats are tested per year (Clément et al., 2002). Rate of improvement in France was reported to be 12.53 and 13.65 kg/year over the last 10 years (Clément et al., 2002) in Saanens and Alpines, respectively. Other countries test varying numbers of goats, from tens of thousands (Spain, Norway and Italy) to a few thousand (Switzerland, USA and Canada), and in such cases, genetic trends are much smaller (Montaldo and Manfredi, 2002).

An important limitation on the success of these programs is in the speed (or lack thereof) at which improved genetics turns over in the herds. In typical progeny testing schemes, bucks are not evaluated and selected until they have 40 or more daughters with milk records. Considering that it is biologically possible to turn bucks over every year, this is a significant limitation leading to increase in generation interval and a proportionate reduction in the rate of genetic improvement. Another limitation, even in such a large population as France, is relatively low selection intensity (top 50%) of progeny tested bucks. In fact, most of the progress in such schemes comes from pre-selection of bucks to progeny test based on their parent genetic evaluations.

Juvenile selection scheme

An alternative approach, which doesn't seem to have been applied in dairy species, is to focus selection entirely on the young bucks based on parent genetic evaluations (Sullivan, 2002b). In this approach, bucks are turned over every year, a larger number of bucks are selected and there are fewer progeny per buck. The approach has been applied in other species, such as for litter size in swine (Sullivan, 2002a), and annual improvements of more than 2% of breed average have been observed.

Sullivan (2002b) estimated that gains with this approach would be about 30kg increase of milk per lactation for each year of selection. After 10 years of selection, herd averages would increase by 300kg per goat. Figure 1 compares this rate of improvement to what could be expected under a progeny testing scheme.

A key element to the success of this program is limited use of any individual young sire, and therefore use of a relatively large number of young sires. Because individual sires are evaluated with very low accuracy, it is difficult to know which sires are truly the best. However, it can be definitely predicted that some of the best are among the group selected, and the daughters of the best bucks will tend to perform well in the next generation.

The juvenile scheme avoids problems due to inbreeding, which would otherwise be a serious limitation in small populations with few sires selected.

Figure 1. Expected improvement in milk yield

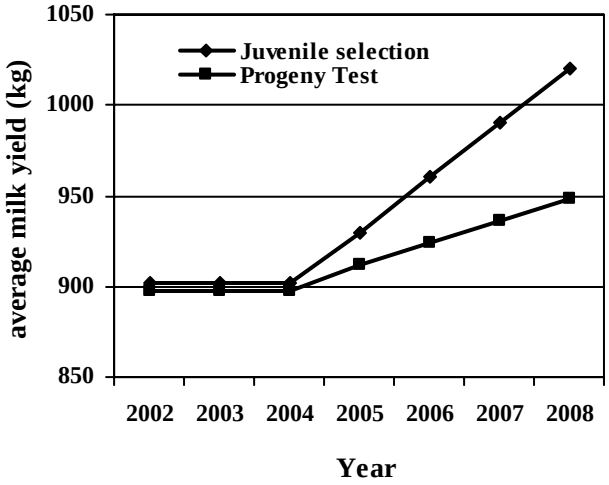
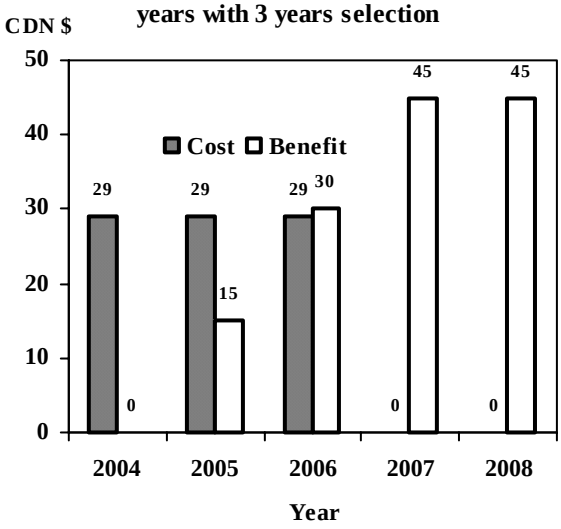


Figure 2. Cost - Benefit per doe in 5 years with 3 years selection



Discussion

The selection tools available to Canadian breeders are based on genetic evaluations for milk, fat and protein yield, fat%, protein% and 8 linear type traits. These genetic evaluations are combined into a selection index in such a way that milk yield will increase rapidly while the other traits will show modest improvements at the same time.

A web-based program available on the Internet (www.ccsi.ca/goats) allows participating producers to enter new parent information and instantly have young kids evaluated and ranked based on the genetic evaluations of their parents. The evaluations of the parents will be updated bi-monthly using new records that accumulate on a regular basis.

Figure 2 compares the cash outlay to the benefit, assuming a total cost of $29 CDN per doe per year for registration, milk recording and type classification. The net benefit would be the return for the producer's time and effort put into the program.

It is expected that selection using a juvenile scheme will lead to an increase of 30 kg milk/year. Assuming marginal profit of $0.50/kg the total benefit over 5 years is $135/doe. Total Cost is only $87/doe. Since genetic improvement is permanent, the $45 benefit/year after 3 years of selection will continue indefinitely (2007, 2008, 2009, and so on) even if a producer quits the program after 3 years. However, continuing on the program will lead to larger and larger benefits.

Conclusions

This juvenile selection program will be a key factor in the development of a sustainable and expanding dairy goat industry in rural sectors of Canada. Fast generation turn-over and higher selection intensity will provide an increased rate of genetic progress compared to a conventional progeny testing scheme. It is expected that after a few years, the cumulative net value of genetic improvement will be quite substantial and will become even larger as more and more goats become part of the program

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Practical uses of decoquinate to control protozoan infections in goats

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Abstract

The purpose of this paper is to indicate the practical uses of decoquinate treatment in goats to control protozoan infections and to improve growth and milk production. Decoquinate is extensively used to control coccidia preventing the disease on farms with clinical signs, to prevent toxoplasmosis although no experimental studies have been run on goats and to prevent diarrhea due to *Cryptosporidium parvum* before and after parturition. But in goats as in sheep treatments over the period starting a week before and 75 days after weaning improve the growth of young goats and their milk performance at first lactation on farms without clinical signs of coccidiosis.

Keywords : goats, decoquinate, growth, lactation, coccidiosis, protozoan infection.
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Introduction

Decoquinate is a non-antibiotic molecule classified in Annex II to Council Regulation (EEC) No 2377/90 for its MRL. Its means a zero withdrawal period in France for beef and lamb meat. It is of very low acute toxicity by the oral route in a range of avian and mammalian species. It is active against certain protozoa : coccidia (Mage *et al.*, 1995), cryptosporidia (Mancassola *et al.*, 1997), toxoplasma (Buxton *et al.*, 1996)., neospora (Lindsay *et al.*, 1997),(Journel *et al.*, 2001). Decoquinate has already been shown to reduce oocyst shedding and improve growth in several ruminant species, including young goats (Foreyt *et al.*, 1986, MAGE *et al.*, 1995 , Morand-Fehr *et al.*, 2000, 2002) , and to increase milk production of replacement goats (Morand-Fehr *et al., 2000)*. The objectives of this paper are to indicate and describe the practical uses of decoquinate treatments in goats to control various protozoan infections and to improve growth and milk performances from experimental work and observations on field.

Control of protozoan infections

Coccidiosis

In young goats, clinical coccidiosis with diarrhea, sometimes bloody, is regularly observed. Subclinical coccidiosis impairing growth and body development without any clinical sign is much more frequent.

Decoquinate is extensively used to control coccidia, preventing the disease in farms with clinical signs and improving substancially growth in other farms. The dosage is 1 mg / kg live weight (as for lambs in the EU) for a minimum period of 30 days. Results with longer periods are shown below. It is cleared in the US for goats and used under vet prescription in some EU countries (off label). In one study, goats were orally inoculated with oocysts ; non treated goats developed profuse diarrhea whereas treated goats (3 dosages : 0.3,0.5,1.4 mg / kg lw) did not develop clinical coccidiosis and gained significantly more weight with significantly fewer oocysts in the feces (Foreyt *et al.*, 1986). Mage *et al.*, (1995) brought to the fore a reduction of oocyst excretion by 86 % in naturally infected goats and a significantly improved weight gain (+ 25 % after 60 days) and feed conversion ratio (-20 %) with a dosage of 1mg decoquinate / kg live weight (L.W.).

Toxoplasmosis

Toxoplasma may cause abortions and neonatal losses in infected goats and ewes especially during first pregnancy. Decoquinate reduces the effect of toxoplasmosis in experimentally infected pregnant ewes (Buxton *et al.*, 1996). In one study, feeding decoquinate to ewes at 2 mg /kg L.W. daily, from 10 days before an oral challenge with *T. gondii* at 90 days of gestation, reduced the overall severity of the fever and delayed the production of antibodies to the parasite. It was associated with less placental damage attributed to toxoplasmosis, a longer mean gestation period, and increased birth weight and number of live lambs

(Buxton *et al.*, 1996). A field trial was conducted using 2 groups of toxoplasma-seronegative ewe-lambs, fed either 2mg decoquinate/ kg L.W. daily or unmedicated feed for 8 weeks prior to lambing. Only 2.6 % of decoquinate medicated ewes failed to lamb, compared with 23 % of unmedicated animals, (Millard *et al.*, 1993). It is cleared in the UK "as an aid in the prevention of abortions and perinatal losses due to toxoplasmosis by medication of ewes feed" at the dosage of 2 mg / kg L.W. for the final 14 weeks prior to lambing. Although no experimental studies have been run on goats, decoquinate is used to prevent toxoplasmosis in field conditions.

Cryptosporidia.

Cryptosporidiosis is a parasitic disease due to a protozoan : *Cryptosporidium parvum.* It causes severe diarrhea in ruminant neonates. In this experimental young goat infection (Mancassola *et al*, 1997), a decoquinate treatment (2.5 mg / kg / day for 21 days) prevented diarrhea. Fecal examination showed that every animal was infected with *C. parvum.* Nevertheless, decoquinate reduced oocyst shedding and its duration, thus decreasing environmental contamination. Immunological results confirmed the parasitic development with the appearance of an acquired immunity in the medicated group as in the untreated group.

The treatment must be done before and after parturition. In ewes the dosage was 1.5 mg / kg L.W., while in beef cows it was 1.25. Under field conditions, this prevention has been used successfully several times in goat flocks infected with cryptosporidia. As there is no MRL for milk, according to EU rules, an 8-day withdrawal period for milk must be respected .

Improvement of performance in goats

As first experiments (Foreyt *et al.*, 1986, Mage *et al.*, 1995) showed that decoquinate treatments to prevent clinical coccidiosis resulted also in growth improvements, further experiments were undertaken in farms where coccidiosis had not clinically appeared for years in order to know whether in such cases growth performances and milk production at first lactation could be systematically improved by a treatment at weaning, a very stressful nutritional period for young goats.

Decreased growth rates may indeed have considerable consequences on either dairy or suckling farming. In intensive goat milk production systems, farmers try to have the young goats mated as early as possible (*ie* around 7-8 months of age) so that they have their first lactation as early as at the age of 1 year (Morand-Fehr *et al.*, 1996). Should the young goats not have a sufficient weight, mating would be delayed by 2 or 3 months resulting in a shorter first lactation period or even, mating could be delayed by a whole year since the sexual season only lasts 4-5 months. In any case this means an economic loss to the farmer in terms of milk production.

In more extensive suckling goat farms, the objective of which is producing kid meat, a type of breeding most found in tropical areas, young goats meant for flock replacement will show clear signs of slowed growth and poor body conditions when affected by coccidiosis. This is a rather frequent cause for delayed first fertile mating and non optimal number of kids produced per goat in the herd. A first experiment with animals divided into lots (Morand-Fehr *et al.*, 2000, 2002a) showed that a short treatment until 35 days after weaning (1 mg decoquinate per day and per Kg L.W.) increased by approximately 8 % the live weight of young goats as early as 1 month after weaning, compared with a sulfadimerazine treatment, a result that was maintained until 4 months after weaning. The same treatment, but until 75 days after weaning (long treatment) led to similar but slightly higher results at 3 or 4 months after weaning.

Live weight at mating, total weight of the litter and milk production of young goats administered the short treatment were slightly increased as compared with young goats receiving the sulfadimerazine treatment, but never significantly. However, weight at mating and at dropping and milk production of young goats receiving the longer treatment were significantly higher. At 200 days of lactation, these primiparous goats produced more than 50 kg milk, that is, over a simulated whole goat lactation period, an increased milk production by 56-60 kg.

A second experiment conducted under individual feeding conditions followed the same protocol as previously. The shorter as well as the longer decoquinate treatments clearly improved growth rates over the treating period owing to both increased intake level and better feed conversion (+ 21 %).

An experiment comparable with the first experiment on young goats was carried out with a similar protocol on ewe-lambs aged 4 to 15 weeks in a herd of Lacaune dairy ewes. Results (Morand-Fehr *et al.*, 2002b, 2004) were very much comparable with those observed on young goats.

Conclusions

In goats, decoquinate can be used to control coccidiosis, toxaplasmosis and cryptosproridiosis as in other ruminants. But in this species as in sheep, treatments over a period starting a week before weaning and until 75 days after weaning improve the growth of young goats and their milk performance at first lactation. Such a treatment secures the farmer and allows the mating of young goats to take place at 7-8 months which leads to improved economic results thanks to a higher level of milk production at first lactation.

The experiments conducted on goats took place on intensive dairy farms. In beef-cows breeding and ovine-suckling systems, decoquinate is regularly used to improve growth performances. Experiments on suckling goats will have to confirm that similar results can also be obtained with this species.

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Improving the livelihoods of resource poor farmers through goat development projects: Heifer Zimbabwe and AREX (Matopos Research Station)

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Summary

Heifer International Zimbabwe (Heifer) and Matopos Research Station (MRS) have embarked on a joint implementation program for promoting goat production in the dry areas of Zimbabwe. The focal geographical areas for the goat projects are the dry (agro-ecological region 4 and 5) areas, which are highly fragile environments with limited options for food production. MRS has used participatory technology development approaches in its research approach, dominated by participatory adaptive trials, farmer led research, and on farm research. Heifer has also employed participatory approaches in selecting suitable goat production technologies, for example, housing, health and general management, identification and training of beneficiaries. The overall objective is to promote goat development to end hunger and poverty by providing and promoting the use of superior goat genetic material and providing production and management skills to the beneficiaries. The goat is also being used as an agent for ecological change. More relevant farmer generated research has come about particularly the strengthening of the ethno-veterinary technologies and housing. About 800 families have been assisted with more than 4000 does and 200 bucks. The promotion of nitrogen fixing trees has greatly improved the environment and many of the former resource poor farmers can now sell a goat to send their children to school. Nutritional and income levels have improved through the consumption of milk and meat, and the sale of skins, milk and meat in improving HIV/AIDS victim's life lines. Opportunities, constraints, and challenges still present themselves and more effort is being called for in order to see a more meaningful change through goat development projects.

Key words: goat development projects, fragile environments, hunger and poverty, collaborative efforts
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Introduction

The last decade has been characterized by frequent and severe droughts, which has aggravated the desertification process in the drier and marginal areas of Zimbabwe. The droughts have increased the fragility of the areas reducing the potential for crop and large ruminant production. The general increase in the human population has pushed people into less productive areas, formally grazing and game areas increasing the threat to livelihoods and environmental degradation. A general reduction in the options for food production has led to increased hunger, poverty and deterioration of the livelihoods. The greatest challenge has been to identify and select more genetically suitable and environmentally adapted crop and livestock species for these fragile environments.

Goat production in Zimbabwe is largely of a subsistence nature characterized by uncontrolled breeding leading to inbreeding depression, poor management practices (housing, nutrition and health) and predominance of a poorly developed informal market. Resource poor and illiterate farmers are usually skeptical about the adoption of conventional scientific research technologies. Despite this background the goat remains one of the most suitable vehicles, among the few available options, for ending hunger and poverty and improving food security in the marginal areas. Heifer International Zimbabwe (Heifer) and the Department of Agricultural Research and Extension (AREX)-Matopos Research Station (MRS) have jointly embarked on goat development projects in the drier parts of Matebeleland North and South, Masvingo, Manicaland and the Midlands provinces. The collaborative approach has seen the development of ten goat projects, directly benefiting more than 800 families through distribution of more than 4000 does and 200 bucks (Table 1). More joint goat development project proposals have been developed for further funding. This paper attempts to highlight the collaborative efforts by Heifer, MRS and needy families, to strengthen the contribution of goats in improving the food security and the livelihoods of resource poor families in the dry and fragile environments of Zimbabwe.

Background

Zimbabwe has a total human population of 14 million. More than 50% of the population resides in marginal dry regions of the country and their livelihoods are purely agro-based. The recurrent nature of droughts has reduced productivity of these areas and has left the majority of the households living below the poverty datum line characterized by high illiterate levels due to high rates of school dropouts. The livestock ownership trend is very low considering the low potential for crop production in these marginal areas. Only 43%, 33%, 17% and 3% own cattle, goats, donkeys and sheep respectively. Average goat ownership per family is four with goat herd sizes ranging from 0-250 animals. The national goat population currently stands at 3.9 million with 75% of this population being in the 5 focal geographical project areas of Midlands, Masvingo, Manicaland, Matebeleland North and Matebeleland South provinces. This gives a good indication of a high potential for goat production and yet a very disappointing ownership trend. Many people don't have goats yet others can raise 250 goats. The current effort is to try to increase the number of farmers owning goats from the current 33% by assisting non-goat owners. Heifer International Zimbabwe (Heifer) is a non profit making non governmental organization whose mission is to end hunger and poverty through assisting needy families/communities with livestock related development projects which also assist in the improvement of the environment. The identified communities/families receive training in project management, livestock management, fodder production and marketing skills and they pass on the skills together with the first female offspring from each given female goat to one other needy family through the key pillar concept of "Passing on the Gift"-POG. Matopos Research Station (MRS) is an agricultural research institute under the Department of Agricultural Research and Extension (AREX). It has largely been responsible for the development of livestock production technologies and by virtue of its location in the dry parts of the country has developed a variety of goat development technologies on station and on farm.

Community groups

Heifer assists poor resource farmers. The most vulnerable groups are women and children and people living with HIV/AIDS joining the group of late. Heifer has made a deliberate effort to target these disadvantaged sections of society by undertaking community gender audits and encouraging voluntary HIV/AIDS testing. These members form the pool from which most of the project beneficiaries are drawn.

Implementation

Institutional roles MRS has the responsibility of identifying and developing goat production technologies on station and on farm. Participatory research techniques have emphasized farmer-initiated research, participatory adaptive trials and participatory technology development through on farm research. Farmers have played a key role in the development of goat housing, ethno-veterinary and breeding technologies. They have been instrumental in the selection for twinning ability, mothering ability, milk production and growth rates by creating and pooling group production records. Farmers provide indigenous does and MRS provides the pool of indigenous bucks for meat production (and milk production). The farmers come to the station to exchange bucks for breeding purposes. MRS is currently working with farmer groups to develop informal goat marketing systems.

Heifer buys and distributes large framed indigenous does and Boer bucks to the needy families. Each family receives 5 does and one buck and will pass on the first female offspring of each dam plus one buck. The POG process has become widely accepted and several NGOs have adopted the principle. Beneficiary farmers receive training in project management, goat production and management, animal health and marketing skills. On receiving goats farmers sign contract forms to agree to pass on the offspring and attained skills. One of the key roles of both Heifer and MRS has been the development of training materials in English and vernacular languages for extension staff and farmers. Experienced members of old project groups have been instrumental in farmer-to-farmer training as well as the recently introduced farmer field schools. These approaches have seen a wide technology adoption rate and increased goat production in the project areas. The beneficiaries also receive training in fodder tree production and seed/seedlings for the NFTs, *Leucaena leucocephala*, *Acacia anguistissima*, and moringa, before receiving the goats. An initial target of 200 trees is set for the farmers who can later increase the number. Training of two community animal health workers (CAHWs) per group is part of the project development package. It is surprising to note the high degree of concept and skills mastering by these CAHWs despite their low educational level. This will improve the sustainability of the project through improved animal health delivery against a

deteriorating public animal health delivery system. The CAHWs undergo a two-phase training program of two weeks. Heifer supplies the seed drugs and materials to the CAHWs who in turn use them on a cost recovery program for both members and non-members.

Heifer has embarked on a market development program and, in line with this farmer-led market surveys are being conducted. Heifer has already put up an abattoir in Binga district, one of the most active goat-project areas.

Monitoring and evaluation

Heifer, MRS and the farmer groups take an active role in the monitoring and evaluation processes. Participatory value based planning (PVBP) and project self-review and planning (PSRP) are the key approaches used. These processes have an enormous empowerment influence on farmers. They can now plan and evaluate their own projects.

Current constraints

* The predominance of poor genetic material (inbreeding effect) in the communal areas where Heifer draws its does from
* Animal movement restriction due to Foot and Mouth Disease out-breaks and veterinary boundaries
* Disease and parasites due to lack of dipping and dosing which increase mortality rates
* Reduced feeding time due to lack of labor where goats are only let out in the afternoon
* Uncontrolled breeding which results in kidding taking place all year round.
* Poor goat management skills (nutrition, breeding, housing and marketing)
* Lack of organized conventional and informal goat markets
* Farmer attitudes towards goats, which has dubbed goats as inferior animals of a subsistence value

Opportunities

* Current beef shortages and prohibitive prices should see an increase in goat meat demand
* The under utilized cold storage company slaughter facilities and the newly constructed Binga abattoir are ready to improve conventional goat marketing
* Suitability for goat production coupled with the increasing unsuitability for cattle production options in marginal areas
* The existence of a strong research and extension support base
* The recent deliberate shift in emphasis by Heifer from large stock to small stock in marginal areas and use of the widely accepted “Passing-on-the-Gift” (POG) approach

Impact

* An average of 20 bucks are drawn from Matopos Research buck pool per year per district in Matebeleland North and South provinces
* High adoption rate for on farm tested technologies and improved conservation of indigenous acacia trees in the dry regions where goat projects have been established
* Non project members have benefited from the good bucks supplied by AREX and Heifer and body size in these areas has visibly increased
* Agro-forestry activities in the project areas have seen an increase in the number of exotic and indigenous browse species improving both the environment and feed resource base
* Nutrition gardens have been established in all goat project areas to take advantage of the high quality of goat manure to improve human nutrition
* The use of goat milk has increased in all project areas with yields ranging from 200ml-600ml per goat per day and this has seen a reduction in nutrition related diseases and better meals for people living with HIV/AIDS

Table 1 Goat distribution by Heifer Zimbabwe

DISTRICT	Number of original placements		Number of original beneficiaries			Total number of beneficiaries for original placements and POGs
	Does	Bucks	Female	Males	Total	
Binga	410	58	47	35	82	172
Gokwe	150	30	19	11	30	143
Mutare	55	11	5	6	11	132
Chiredzi	125	25	16	9	25	250
Gweru	225	35	32	13	45	45*
Total	965	159	119	74	193	742

* a new group that has recently (2003) benefited

Conclusion

The use of goats as vehicles for improving food security and livelihoods in marginal areas is receiving wide acceptance among resource poor illiterate farmers and the use of participatory technology development and scaling up enhances both adoption and sustainability. The collaborative approach to rural development remains crucial in reducing duplication of efforts in rural development. There is a wide scope for small-holder goat production in the dry areas of Zimbabwe but careful selection and screening of available technologies is imperative. The goat remains one of the most suitable agents for ecological change in the highly fragile environments where large ruminants can aggravate degradation through hoofing and grazing.

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Influence of ration processing on the carcass characteristics of Saanen kids slaughtered at different ages

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Abstract

The effects of the ration processing on the carcasses characteristics of Saanen kids was examined in a 3x3 factorial experiment. Thirty-six kids were distributed in the following treatments: control (ground total ration), peletted total ration and extruded total ration and these animals were slaughtered with 30, 45, and 60 days of age (being 12 animals per age), randomly allocated to treatments. Immediately after slaughter, the animals were eviscerated and the gastrointestinal tract was weighted full and empty. After that, the carcasses were weighed to determine the biological carcass yield and were chilled to determine the commercial yield. Carcass length was measured and carcass compactness calculated. In the sections of the 13rd thoracic vertebra and the first lumbar vertebra, the ribeye area was determined. The pelleting of total ration favored an increase intake and an increase average daily gain and consequently, higher slaughter weight was observed. Animals with 60 days of age that received this ration showed higher length of the carcass and greater compactness. The pelleting and extrusion process did not affect biological carcass yield, cold carcass yield or the ribeye area of the animals.

Keywords: Carcass characteristics, compactness, extrusion, peletted diet, ribeye area, yield
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Introduction

In the South-west of Brazil, the majority of goat farmers keep dairy goats. In these production systems meat provides an additional income particularly the animals are slaughtered at a young age because the relatively low costs and high quality of the carcasses with better quality to be commercialised (Colomer Rocher, 1987).

Using simple measurements and with low cost, the producers can obtain important information that can help in the animals evaluation, and influence in the visual perception of the consumer, affecting the goat meat market, e. g., values of the compactness to predict the muscle quantity of the carcass (YÁÑEZ, 2002) or values of the yield, used to indicate the available product quantity to commercialisation (STANFORD *et al.*., 1995).

Several chemical and physical treatments, such extrusion and pelleting, are used in the ration processing with the objective to improve the utilization efficiency of the diet but, the effect of this processing on the carcasses characteristics of the kids are lacking in the literature. Thus, the objective of the study was to evaluate the effects of the ration processing on the carcasses characteristics of Saanen kids slaughtered with 30, 45, and 60 days of age.

Materials and methods

Thirty-six Saanen kids were distributed in the following treatments: control (ground total ration - GTR), peletted total ration (PTR) and extruded total ration (ETR) and these animals were slaughtered with 30, 45, and 60 days of age (being 12 animals per age), randomly allocated to treatments. The average daily gain (ADG) was determined weighting the animals were at birth and every week before feeding, in the morning. All kids were weaned at 45 days of age.

The ingredients of the total rations were: corn hay (40.00 %), ground corn (29.26 %), soybean meal (21.82 %), sugar-cane molasses (4.84 %), soybean oil (0.91 %) and minerals (3.17 %). The chemical composition (% dry matter) was 16.5% crude protein (CP); 31.0 % neutral detergent fibre (NDF); 19.5 % acid detergent fibre (ADF) and 8.8 % ether extract. All kids were offered total ration twice daily after 15 d of age. The intake was checked daily and the refusals were removed from the feeders daily and weighted.

The water and the ration of the animals were taken out 12 and 24 hours before slaughtering, respectively, being determined the slaughter weight (SW). Immediately after slaughter, the animals were

eviscerated and the gastrointestinal tract (GTI) was weighted full and empty to allow the calculation of the internal content of the GTI and this measure, was used to determine the empty body weight (EBW) that is the SW - (internal content of GTI + urinary bladder + gall bladder). After that, the carcass was weighed to determine the biological carcass yield (BCY), i. e., the relation between the warm carcass weight (WCW) and the EBW.

The carcasses were chilled in refrigerator for 24 hours at 4°C and weighed to determine the commercial yield (CY) that is the relation between cold carcass weight (CCW) and the SW. The carcasses length, i. e., the distance between the cranial-margin of the pubis and the cranial- margin of the first rib in the medium point, was obtained using a tape line. With this measure, it was possible to calculate the carcass compactness, i. e., the rate between CCW and the length of the carcass (LC). In the sections of the 13rd thoracic vertebra and the first lumbar vertebra, the ribeye area (RA) was determined in cm^2, by the GRADE-UNESP method (YÁÑEZ, 2002).

The animals were assigned in a randomised complete design with a 3x3 factorial (three ages, three rations) with four replications. The means were analysed by Tukey's HSD using the General Linear Models procedure (SAS, 1999).

Results and Discussion

Tables 1 and 2 provides a summary of the averages and the coefficients of variation of the daily weight gain, carcass yield, ribeye area, length of the carcass and compactness.

Table 1- Averages and coefficients of variation of slaughter weight (SW), the average daily gain (ADG), biological carcass yield (BCY), commercial carcass yield (CY) and ribeye area (RA) of the Saanen kids fed with ground total ration (GTR), peletted total ration (PTR) and extruded total ration (ETR), slaughtered with 30, 45, and 60 days of age.

Age (days)	SW (kg)	ADG (g/day)	BCY (%)	CY (%)	RA (cm^2)	RA/CWC* (cm^2/kg)
30	5.48c	0.132a	59.05a	51.57a	2.45b	0.79a
45	7.25b	0.112a	60.70a	47.82b	3.20ab	0.86a
60	8.78a	0.117a	59.65a	45.83b	3.25a	0.76a
Total Ration						
Ground	6.37b	0.101b	59.77a	49.46a	2.91a	0.86a
Pelleted	7.85a	0.138a	58.86a	48.47a	3.21a	0.80a
Extruded	7.28ab	0.121ab	60.80a	47.29a	2.77a	0.74a
CV %	13.42**	16.12**	4.29 NS	5.79**	25.90*	22.21 NS

* RA was calculated in relation to the hot carcass weight.
[a,b] Means within a column followed by different letters differ significantly *(P<0.05); ** (P<0.01).

Table 2- Averages and coefficients of variation of the length of the carcass (LC) and compactness (COMP) of the Saanen kids fed with ground total ration (GTR), peletted total ration (PTR) and extruded total ration, slaughtered with 30, 45 and 60 days of age.

Age	Length of the carcass (cm)			Compactness (kg/cm)		
(days)	Ground	Pelleted	Extruded	Ground	Pelleted	Extruded
30	38.62aB	40.12aB	41.12aA	0.06aA	0.06aB	0.08aA
45	43.57aA	42.87aB	43.70aA	0.08aA	0.08aB	0.08aA
60	44.87abA	46.87aA	42.17bA	0.08bA	0.11aA	0.08bA
CV %	4.60**			15.11**		

[a,b] Means within a line followed by different letters differ significantly **(P<0.01).
[A,B] Means within a column followed by different letters differ significantly ** (P<0.01).

The current study showed that in both weaning and post-weaning periods the DMI increased by approximately 26 % in animals that received PTR (P<0.05) compared to animals that received GTR,

consequently, animals fed with PTR exhibited higher ADG in relation to the animals fed with the other rations and showed higher ($P<0.01$) LC and COMP in animals of the 60 days of the age. The animals were weaned with 45 days of age, and thereafter the dry matter intake and weight increased ($P<0.01$).

In a series of experiments with goats, researchers observed that the percentage of the carcass yield, varied between 35 and 60 %, but these differences depends on method used. In the present study it was established that the averages of the BCY were approximately 60 % because the EBW was used as calculation bases and because the content of the GTI represented 12 % of the SW of the animals. The weight losses during chilling, showed higher values (approximately 7 %) in relation the values determined by RESENDE (1989) and GIBB *et al.*. (1993), i. e., 3.7 % and 1.1 % respectively. The low quantity of the external fat deposition in the carcass of the young animals also contributed to the increase of losses.

It was observed that the animals with 30 days of age showed higher CY in relation to the animals with 60 days of age. Several authors observed that in goats the increase weight did not affect the yield of the carcass (WARMINGTON & KIRTON ,1990). However, other researchers obtained opposite results, relating increase of the yield as the live weight increased.

The RA was different among ages, being higher ($P<0.05$) in the animals of 60 days of age and indicating higher muscles quantity in the carcass. The rate RA/PCQ did not differ among ages and these values were similar with the values obtained by YÁÑEZ (2002). Carcasses of greatest quality need contain a higher proportion of muscles, low proportion of bones, and adequate fat quantity providing succulence, flavour, and to minimising the losses during storage.

Statistical analyses showed that a significant interaction occurred between age and ration in relation to the carcass length and compactness. YAMAMOTO *et al.*. (2000) and ZUNDT *et al.*. (2001) observed in adult animals, values of the compactness higher than the values observed of this study.

Conclusion

The pelleting of total ration favored an increase intake and an increase average daily gain and consequently, higher slaughter weight was observed. Animals with 60 days of age that received this ration showed higher length of the carcass and greater compactness.

The pelleting and extrusion process did not affect biological carcass yield, cold carcass yield or the ribeye area of the animals.

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ECONOMICAL AND SOCIOLOGICAL DEVELOPMENT THROUGH MANAGEMENT OF FIBROUS FORAGES

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Abstract

Utilization of fibrous forages is a key component to improve economical and sociological environments, diminishing cost and creating farm labor, throughout many developing countries. High feed conversion efficiencies can be achieved by ruminants on poor quality forages supplemented with key nutrients and non-protein nitrogen. Two studies indoors and on grazing were performed in winter and summer respectively. Experimentally 80 kids, plus two cannulated animals were fed corn stubble (CS) 700g /d and alfalfa hay (AH) 100g /d, with 100 g/d of a slow intake 5% urea mixture (SIUS) detailed before (Galina *et al., 2004a*). In the second study alfalfa 550 g/d alfalfa hay (AH) with 350 g/d of a concentrate (BC), 16% CP were fed. On the summer observation pasture was supplemented with SIUS. Alpine goat kids 19.41 (±.51) kg body weight (BW) plus cannulated goats performed in a production trial. First diet (n=43 plus two cannulated animals) 18.41 (±1.7) kg/BW were pastured daily, supplemented with 200 g/d of SIUS. A second diet was study to measure grazing with BC supplementation in 43 kids 19.12 (±1.1) offered 300 g/d of a balanced concentrate (BC). Both groups were managed on pasture divided by a solar mobile electrical fence. Total dry matter intake (DMI) were 1,010 ± 283 g/d for SIUS and 747 ± for BC ($P<0.05$). Digestibility and intake was improved in kids supplemented with CS/SIUS, and they had superior weight gain indoors 112 ±23 feed CS or in pasture of 101±18 g/d over AH/BC kids with 86±31 g/d in confinement or 83±26 when grazing.

Keywords: Nutrition, goats, growth, cheese, rangeland, pasture.

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Introduction

Utilization of fibrous forages is a key component to improve economical and sociological environments, diminishing cost and creating farm labor, throughout many developing countries. High feed conversion efficiencies can be achieved by ruminants on poor quality forages supplemented with key nutrients and non-protein nitrogen (Galina *et al.,* 2004a*;* Ortíz *et al.,* 2002). Sufficient energy could be supply by maize stubble cell walls if celullolisis is improved (Puga *et al*., 2001; Galina *et al., 2004b*).

Microbial protein formation could balance goat's nitrogen needs (Galina *et al.,* 2004c). Under laboratory conditions many factors can be studied in detail, but few investigations have been attempted to elucidate simultaneously the interactions that results on field trials (Leng, 1990). Urea as source of NPN is converted via ammonia into microbial protein thereby supplying additional nitrogen to the host animal (Ortíz *et al.,* 2002). Intermittent feeding of urea normally leads to several peaks of ammonia-N shortly after ingestion (Galina *et al.,* 2003). Economical and sociological development could be achieved adding low degradable protein and carbohydrates to the diet using regional resources, diminishing cost and improving households economics (Galina *et al.,* 2003). One satisfactory approach to improve microbial fermentation is to provide ammonia continuously (Ortiz *et al.,* 2002).

Material and Methods

Two studies indoors and grazing were performed in winter and summer respectively. First observation rearing in corn stubble based diet on Alpine kids (12.50 ±0.355 kg BW), evaluating voluntary dry matter intake (VDMI), organic matter intake (OMI), rumen degradation, and rate of passage, NH_3 concentration, VFA´s, apparent digestibility, pH, total fermentable carbohydrates, and weight gains. Experimentally 80 kids, plus two cannulated animals were fed corn stubble (CS) 700g /d and alfalfa hay (AH) 100g /d, with 100 g/d of a slow intake 5% urea mixture (SIUS) detailed before (Galina *et al., 2004a*). Traditionally alfalfa has been used in kids in diets composed by 550 g/d alfalfa hay (AH) supplemented with

350 g/d of a balanced concentrate (BC), 16% CP. On the summer observation pasture was supplemented with SIUS. Alpine goat kids 19.41 (±.51) kg body weight (BW) plus cannulated goats performed in a production trial. First diet (n=43 plus two cannulated animals) 18.41 (±1.7) kg/BW were pastured daily, supplemented with 200 g/d of SIUS. A second diet was study to measure grazing with BC supplementation in 43 kids 19.12 (±1.1) offered 300 g/d of a balanced concentrate (BC). Both groups were managed on pasture divided by a solar mobile electrical fence.

Results and Discussio

When tested VDMI and OMI were similar in the CS/SIUS compared with AH/BC goats. NH_3 concentration and degradation and non degradable fractions were augmented by SIUS (P<0.05). Rumen pH rose at 2 hr after when CS/SIUS was offer and stayed above 6.60 for 8 hr, while the rumen pH in AH/BC goats decreased to 5.57 by 6 hr. Thereafter, and rose again to 6.50 after 12 hr. N intake increased from (SIUS) 18.60 g/d *versus* 14.57 in BC (P<0.05). *In vivo* nitrogen digestibility was 76.63% in CS/SIUS and 54.16% in AH/BC (P<0.05). *In vivo* DM, OM, and hemicelluloses digestibility was similar among groups. NDF degradation was higher for CS/SIUS (P<0.05). Degradation rate of NDF constant (k_d) was different favoring SIUS diet (P<0.05). Degradation rate for hemicellulose was similar between diets. Passage constant (k_p) for NDF differed between diets 0.036/hr for AH to 0.081/hr for CS (P<0.05). True digestibility was higher (P<0.05) in CS/SIUS (46.24%) from AH/BC (36.22%). Non degradable fiber was similar among diets. Disappearance of cellulose in AH/BC, 16.54 hr was less than in CS/SIUS, 29.34 hr (P<0.05). Hemicellulose *in situ* degradation was similar between diets. Passage rate differed 0.034/hr for CS/SIUS and 0.029/hr for AH/BC (P<0.05)). True digestibility in CS, 46.24% was higher than that of AH, 33.22% (P<0.05). The half-time (t ½) disappearance for hemicellulose was 29.14 hr CS/SIUS and 20.16 hr for AH/BC. Growth in 240 days averaged 112 ±9 g/d for CS/SIUS compared to 86 ±7g/d for AH/BC diet (P<0.05). Supplement intake per kg BW ranged from 6.45 to 13.15 g/d by CS fed goats and 10.40 to 19.10 g/d in AH/BC (P<0.05). Ruminal pH was higher, over 6.30 in CS/SIUS diet (P<0.05). NH_3 was higher among CS/SIUS goats (P<0.01). Acetic acid increased (mM/1) in the CS/SIUS diet (P<0.05). Propionic acid showed an increase (P<0.05) in AH/BC diet. Butyric acid did not show differences. Total amount of VFA´s was different when comparing AH/BC and CS/SIUS diets (P<0.01). Supplementation of high fiber diets with NPN improved fermentation and showed higher NH_3 and VFA´s production. SIUS supplied critical nutrients to the rumen, improved DM intake, rate of passage, ruminal pH and resulted in better weight gain than the AH/BC group. Present results showed that high fiber forages could be used efficiently by ruminants (up to 70 to 80% DMI) when ruminal microorganism conditions are improved with a continuous nitrogen supplementation. On pasture kid growth was 101 g/d (±18) for SIUS and 83 g/d (±26) for BC (P<0.05).

Total dry matter intakes (DMI) were 1,010 ± 283 g/d for SIUS and 747 ± for BC (P<0.05). Ammonia concentration and degradation of potential digestible and indigestible fractions were augmented by SIUS (P<0.05). Rumen pH rose slightly following feeding for SIUS kids and remained higher compared with BC kids 12 hr thereafter. Nitrogen intake was similar from SIUS, 118.60 g/d *versus* 122.53, in BC. *In vivo* nitrogen digestibility was more (P<0.05) in SIUS diet (79.12%) than for BC (56.14%). Fiber digestibility was higher (P<0.05) for SIUS. *In situ* DM disappearance did not show differences among diets at 9, 12, 24 and 48 hr of incubation. Digestion rate of NDF constant (k_d/h) was different favoring SIUS diet (P<0.05). Digestion rate for cellulose and hemi cellulose was similar between diets. Passage rate (k_p/h) for NDF was different between diets, 0.059/hr for BC to 0.080/hr for SIUS (P<0.05). True digestibility was higher in SIUS, 48.33% compared to BC 34.11% (P<0.05). *In situ* degradation of potential digestible fiber for cellulose was higher in SIUS 67.14% to BC 53.14% (P<0.05). Indigestible fiber was similar for BC (51.42%) compared to SIUS (66.27%).Time of disappearance of cellulose in BC (17.54 hr) was less (P<0.05) than in SIUS (30.34 hr). Hemi cellulose *in situ* digestion was similar between diets. Digestion rate was higher (P<0.05) in BC. Passage rate was different (P<0.05) between SIUS (0.080/hr) and BC (0.059/hr).

True digestibility in SIUS, (48.33%) was higher than that of BC (34.11%) (P<0.05). The half-time (t ½) disappearance for hemi cellulose was higher for SIUS 31.14 hr as compared to BC 22.14 hr (P<0.05). Propionic acid showed a significant increase with time of sampling in BC diet (P<0.05). Butyric acid production did not show significant differences among diets (P<0.05). Total amounts of VFA´s were different statistically when comparing BC and SIUS diets and allowing higher energy compared to SIUS (P<0.01). Supplementation of high fiber diets with NPN did improve fermentation showing better ammonia and VFA´s production. SIUS intake was consumed in 8 to 10 hours after offer and concentrate in 30 minutes. It was concluded that SIUS supplementation offered critical nutrients to the rumen, improved DM

intake, rate of passage, increase ruminal pH and resulted in better weight gains than BC. Present results showed that high fiber forages could be used efficiently by ruminants (up to 70 to 80% DMI) when ruminal fermentation is improved with a continuous nitrogen supplementation.

Conclusion

Fibrous diets as a prime source of forage can be manipulated in various ways. Digestibility and intake was improved in kids supplemented with CS/SIUS, and they had superior weight gain indoors 112 ±23 feed CS or in pasture of 101±18 g/d over AH/BC kids with 86±31 g/d in confinement or 83±26 when grazing. This was apparently due to elevation of rumen pH and augmentation of degradable bacteria through offering essential amino acids, non-protein nitrogen, sulfur and phosphorus to rumen microorganisms, mixture that may have improved cellulose utilization. Continuous ammonia supplied from CS/SIUS could explain better performance. Direct by-pass from the rumen of protein, glycogenic carbohydrates and long chain fatty acids were probably other key ingredients in the present results. Use of local forage resources allowed the economical feasibility of the diet. This is an example of improving economical and sociological rural environment in a community throughout development of technology.

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Prospects of the goat as a dairy animal in Pakistan

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Abstract

In Pakistan goats are kept primarily for meat production but goat milk is considered to have special value. Goats produce about 607 thousand tonnes of milk annually, which is about 2.3 % of the total milk produced in the country. There are about 25 breeds of goat and some of the goat breeds like Beetal, DDP, Damani, Kamori and Kacchan are famous for meat as well as milk. Beetal and Dera Din Panah (DDP) are breeds of Punjab; while Damani is a breed of North West Frontier Province (NWFP), Kamori and Kacchan are breeds of Sindh province. The breed-wise population is Beetal 2.43 million, DDP 0.10 million and Kamori 3.83 million, whereas the population data of Damani and Kacchan breeds are not available. Milk production potential of Beetal is 272 litres in 140 days, DDP 205 litres in 130 days, Damani 113 litres in 120 days Kamori 204 litres in 115 days and Kacchan 190 litres in 110 days. The average daily milk yield of Beetal is 2L, DDP 1.6L, Damani 1L, Kamori 1.8 L and Kacchan 1.7 L. Due to the increase in human population and shortage of buffalo and cow milk during the scarcity period (May to August), people are using goat milk to cover this lean supply. It is a dire need that dairy aspects of goat production should also be exploited in Pakistan.

Keywords: Pakistan, goat, dairy animal, production
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Introduction

Pakistan has about 25 goat breeds found all over the country with a total population of 50.9 million. There are about five million people who kept goats but are landless or have marginal land holdings. In the opinion of the author goats provide a cash income in some parts of the country. Goats contribute to the health and nutrition of several million people in Pakistan, especially those on the poverty line. In the rural areas of the country, it provides a small but important supply of animal proteins of high biological value plus essential minerals. This is of particular significance for the most vulnerable groups like pregnant and nursing mothers and babies who do not like their mother's milk and so we call the goat the poor man's cow.

Among different breeds of goats DDP, Beetal, Kamori, Kacchan and Damani are classified as dairy goat breeds; they also produce meat as well. Among these breeds Beetal is more popular in Punjab because of milk and meat production. Kamori is popular in Sindh province and Damani in NWFP

Goat production is also a tool for poverty alleviation in arid and semi-arid parts of the country. Its production potential is not fully explored and no systematic research has been conducted on this species so far in the country neither for meat nor for milk production.

Goat production and distribution

According to the Economic Survey (2002) there are 50.9 million goats (Table 1). From 1976 to 1986, the population of goats increased by 0.8 million/year whereas during 1986 to 1996, this number was 1.2 million/year. This trend shows the popularity of goat rearing among the people.

Table 1 Goat population and its distribution (millions)

	1976	1986	1996	2002
Pakistan	21.69	29.94	41.16	50.9
Punjab	7.77	10.76	15.30	18.83
Sindh	4.24	6.86	9.73	12.10
NWFP	4.69	4.10	6.76	8.14
Balochistan	4.44	7.30	9.36	11.55

Source: Livestock census, (1976, 1986 and 1996), Economic Survey, 2001-2002

The annual growth rate of goat is 4.2 percent which is the highest when compared with other livestock species like sheep and cattle (0.4 and 1.9% respectively); whereas, buffaloes are increasing at a rate of 2.9%. This trend shows the preference of these two species, buffaloes for milk and goats for meat and milk.
Punjab has the largest proportion of goats (37%), followed by Sindh (23.7 %), Balochistan (22.7 %) and NWFP (16 %). Among these provinces the goat population has increased at a more rapid rate in Punjab than in Sindh with the decrease of sheep population in these provinces.

Goats are providing about 2.3% of total milk supply in the country. In some parts of the country, goat milk is used as milk for babies because of its nutritional suitability and that is why it is called "a poor man's cow". In some parts of the country, where cow and buffalo milk are not available, then goat milk is the main supply for home consumption.

In Central Punjab, the people are raising goats for milk production. During the lean period (May to August) the milk supply of buffalo/cow is not able to meet the high demand; then it can be met with the goat milk. The price of the goat milk is about US$ 69 per 40 litres; whereas the price of buffalo milk is US $ 78 per 40 litres. But the cost of production of goat milk is much lower compared to buffalo or cow milk.

Production Systems

There are four main systems of production, namely nomadic, transhumant, household and sedentary in various regions of the country since unknown times. As described by Ishaque (1993), the prevalence of nomadic system was highest in Balochistan and lowest in Punjab (26%). Transhumant and household/sedentary systems were highest in the Punjab (47 and 27%, respectively) and household production system was lowest in Balochistan (3%). The goat flocks maintained under nomadic and transhumant system get most of their feed (90%) from the rangelands; whereas the goat population kept under sedentary and household systems get their 25-50% feed from the crop wastes, roadsides and canal sides (Khan *et al*., 1999).

The dairy goat population is depicted in Table 2. As indicated in the Table the population of Kamori goats is highest in Sindh followed by Beetal and DDP goats in Punjab. The population census of Damani and Kacchan breeds is not available.

Table 2 Dairy goat population (millions)

Province	Breed	Population
Punjab	Beetal	1.92
	DDP	0.06
Sindh	Kamori	3.00
	Kacchan	NA
NWFP	Damani	NA

Source: Livestock census, 1996
NA: data is not available

Table 3 depicts the goat milk, total milk and share of goat's milk in total milk production in Pakistan. As shown in the Table, milk production from goats and total milk production are both on the increase over the last few years, which is because of an increase in numbers.

Table 3 Goat milk Production in Pakistan(000 tonnes)

Products	1976	1986	1996	2000
Goat milk	292	464	527	607
Total production	6742	9308	23580	26284
Percentage	4.3	4.98	2.23	2.31

Source: Agricultural statistics of Pakistan 2001-2002

The average milk yield from selected dairy goat breeds of Pakistan are given in Table 4. Beetal goats are the highest producers of daily milk yield followed by Kamori, DDP, Kacchan and Damani.

Table 4 Average milk yield of selected dairy goat breeds of Pakistan

Breed	Lactation Milk yield (L)	Lactation length (days)	Average daily milk yield (L)
Beetal	272	140	2.0
DDP	205	130	1.6
Damani	113	120	1.0
Kamori	204	115	1.8
Kacchan	190	110	1.7

Source: Hasnain,1985, Isani and Baloch,1996

Similar observations were made by Junejo (2003) that the Kamori goat produces 3-5 L/day and the Kacchan produces 2 L/day. In another study, which was conducted in Punjab by Iqbal *et al* (2003) DDP and Nachi are good dairy goat breeds in southern Punjab. In the opinion of the author, due to changes in the ecological zone, milk production also fluctuates. To explore the potential of goats as dairy animals, genetic parameters of milk production traits should be researched.

Recommendation

Pakistan has the famous dairy goat breeds but no comprehensive research work has been done so far. It is recommended that nucleus flocks of the important dairy goat breeds should be established in their respective ecological zone at government farms. These breeds need improvement through better nutrition and long term selective breeding. Continued breeding and selection of these breeds as dual purpose animals could lead to improve productivity by developing the best dual breeds of the sub-continent.

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Availability and quality of *Leucaena leucocephala* over the year

N.F.G. Rethman[1*], W.A. van Niekerk[2] & J.P. Lindeque[1]

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Abstract:

By monitoring the availability of edible (leaves, flowers, pods and twigs) and inedible (fuel wood) components of *Leucaena leucocepha* at monthly intervals it was determined that this leguminous tree had the potential to produce quality forage for use by different classes of stock at different times of the year. Maturation, although ensuring considerable bulk was, however, accompanied by an increase in the proportion of wood, the loss of leaves (especially after frost in winter), a decline in crude protein content and digestibility and an increase in fibre components. These data used in conjunction with data on other feed resources and animal requirements will facilitate the incorporation of *Leucaena* into livestock production systems. There is also the clear need for the development of management strategies which will minimize the negative effects of maturation.

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Introduction

Native pastures in southern Africa are often characterised by poor nutritive value for at least part of the year. Grass pastures and fodder crops, receiving nitrogenous fertiliser, have been widely used in the past to supplement such poor quality pastures. The cost factor, however, mitigates against such practices and, increasingly, emphasis is being placed on the potential of leguminous herbs, shrubs and trees, which will not only fix atmospheric nitrogen but will also provide better quality forage for herbivores and most especially for browsers. *Leucaena leucocephala* is such a species. Although best adapted to humid and sub-humid tropical and sub-tropical conditions it has proved persistent and productive under the semi-arid conditions experienced at Pretoria. It was the objective of this study to characterize this species, in terms of both productivity and quality, under local conditions.

Materials and Methods

The experimental material consisted of a plantation of *Leucaena leucocephala* cv Cunningham established a year prior to the commencement of monitoring at a density of 3 333 plants/ha on the Hatfield Experimental Farm. The site is situated at 28º16'E, 25º45'S at an altitude of 1 372 m.a.s.l., receives a summer rainfall of 650 mm p.a., experiences warm summers (mean maximum of 30ºC in January) and mild winters (mean minimum in July of 1.5ºC, with occasional lows of -10ºC). The observations were made under dryland, or rainfed, conditions. As such it should be emphasized that productivity will vary from year to year, depending on the prevailing moisture and temperature conditions.

The trees were cut back to 15 cm at the start of spring (August) and the regrowth measured at monthly intervals from 10 randomly selected trees. Measurements (on an oven dry basis) included total dry matter production, yield of woody material (greater than 3 mm in diameter), which could be used for fuel, yield of edible twigs (less than 3 mm in diameter), which are readily utilized by grazing herbivores, yield of leaf material and yield of flowers and pods. Samples of the edible components (leaf, flowers/pods and fine twigs) were analysed for: *in vitro* digestible organic material (using the technique of Tilley & Terry (1963) as modified by Engels and Van der Merwe (1967)); nitrogen (using the micro-kjeldahl method recommended by AOAC (1984)); neutral detergent fibre (Van Soest & Wine, 1967) and acid detergent fibre (Van Soest & Wine, 1967).

Results and Discussion

Table 1 Productivity and proportional composition of *L.leucocephala* over 12 months

Spring/Early Summer (Sept – Dec)		
Ton DM/ha	% edible material	Ratio of Leaf : Pods
2.0	75	83 : 17
Late Summer/Autumn (Jan – Apr)		
9.5	48	68 : 32
Winter (May – August)		
0.0	32	38 : 62

Although growth in the early season was slow (±17 kg DM/ha/day), the material on offer was predominantly edible (75 %), declining from 99 % in September to 55 % in December. The ratio of leaf to pods (83 : 17) was strongly influenced by the relatively late onset of flowering. In the next four months there was a rapid acceleration in growth (±79 kg DM/ha/day). Unfortunately this was accompanied by a dramatic increase in woody material (from 25 % in the early season to 52 % in the late season). At this time pods also played an increasingly important role with the maturation of pods. There was no actual growth in the winter months but the standing crop declined in quality with a steady decline in the proportion of edible material (to 30 % by the end of winter) as a result of leaf loss. Frost damage resulted in a decline in the leaf : pod ratio, to 38 : 62. As will be seen from the nutritive value parameters of the different components (leaves, pods and twigs) (Table 2) this resulted in a considerable loss in nutrients during the winter.

The severity of winter frosts, which vary from year to year and from area to area, will, therefore, play a major role in the determination of nutritive value in the winter months.

Table 2 Nutritive value of edible components of *L.leucocephala*

		% Crude Protein	% IVDOM	% NDF	% ADF
Leaves :	Mean	16	55	39	28
	Range*	27 – 10	64 – 44	22 – 46	14 – 39
Pods :	Mean	15	44	53	40
	Range	20 – 14	46 – 40	49 – 57	35 – 46
Twigs :	Mean	8	35	62	53
	Range	13 – 6	49 – 25	58 – 67	41 – 61

* The range refers to values in young succulent material to mature lignified material

The availability and nutritive value of edible components over the year clearly indicates that although there is more bulk by the end of the growing season (and in the winter) there is an increasing proportion of inedible fuel wood (which might be of critical importance to the farmer), and a marked decline (decline in protein and digestibility and increase in fibre) in nutritive value of all the edible components. It was particularly notable that the leaf component, which had a much better nutritive value than both pods or twigs, was characterized by the greatest decrease in nutritive value under local conditions. Not only was there proportionately less leaf in the late summer, autumn and winter but it was characterized by a drastic decline in CP and IVDOM and an increase in NDF and ADF. Because of the major contribution of pods to the edible component in the winter months it was particularly disappointing that this component was characterized by such a poor digestibility and high fibre content at this time.

When assessing such a forage resource for browsing animals it should be remembered that in the early season virtually all the material is within reach of even small statured browsers, and that even pods and twigs have a high nutritive value. High rates of utilization (with little opportunity for selectivity) would, therefore, be appropriate. In contrast, later in the year much of the material would be beyond the reach of many browsers and that which is within reach would be inferior. At this time it would be advisable to permit

selective utilization practices, which would permit livestock to meet their nutritive requirements by selecting the best quality material.

Conclusions

It is clear that although *Leucaena* has a good production potential, and will persist under local conditions, its nutritive value declines in the autumn and winter. Producers considering its usage should, therefore, consider management strategies to increase and retain leaf material and decrease woody components. The availability of such characterisation data also enables the animal producer, together with data on other feed resources and livestock needs, to plan production systems, which will make the best possible use of such a resource.

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Induction and synchronization of ovulation with LH and GnRH analogue in dairy goats

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Abstract

The objective of the trial was to evaluate the effect of GnRH and LH administration on the synchronization of ovulation in dairy goats, outside the breeding season. Forty five dairy goats were synchronized using 60 mg intravaginal medroxyprogesterone acetate (MPA) sponges impregnated for 9 days, together with 200 IU eCG and 37.5 µg cloprostenol on day 7. Animals were randomly alloted to three treatments of 15 animals each. Goats in the control group received 1 ml saline solution, while the LH treatment received 5 mg of LH and the GnRH treatment group received 12,5 µg of analogue gonadotropin-releasing hormone, 24 hours after the removal of the intravaginal sponges. The percentage of animals in estrus was of 100, 73,3 and 66,6% for the control, LH and GnRH treatments, respectively. The time interval from removal sponges to estrus for the control, LH and GnRH treatments were 34.8 ± 10.7 h; 26.5 ± 5.7 h and of 23.6 ± 7.4 h respectively, showing a significantly difference ($P < 0.01$) between the control treatment in relation to both the LH and GnRH treatments. There was no significant difference in estrous duration between the three treatments. The mean time interval from the removal of the intravaginal sponges and ovulation for the three treatments was of 46.6 ± 9.3 h, 52.1 ± 5.1 h and of 41.6 ± 8.7 h, respectively. A significant difference ($P <0,01$) was recorded between the LH and GnRH treatments. Ovulation after treatment occurred on average 21.3 ± 8.6 h, 26.8 ± 4.1 h and of 22.3 ± 13.3 h for the control, LH and GnRH treatments respectively. There was a difference ($P <0.05$) from the outset of the estrus to ovulation in the LH and GnRH treatments in relation to the control. Pregnancy? rates did not differ among treatments. Based on these results the use of GnRH and LH was not efficient in synchronizing ovulation in dairy goats, outside the breeding season. More detailed studies are needed in relation to the time of the treatment and consequent of artificial insemination.

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Introduction

The occurrence of seasonal anestrus limits the productive performance of dairy goats, leading to only a kidding per dam/year. Hormonal treatment for synchronization and/or induction of estrus has been used to aid in artificial insemination (AI) and to reduce the seasonal effects on reproduction in dairy goats. The most common methods used for controlled breeding combine intravaginal progestagen sponges with injections of eCG and an analogue of prostaglandin (PGF2) (cloprostenol), applied 48 hours before the removal of intravaginal sponges. This controlled breeding is done in order to increase the number of kiddings and consequently milk production per year. The objective of this study was to evaluate the effect of the administration of LH or GnRH on synchronization efficiency of ovulation in dairy goats during the non-breeding season.

Materials and Methods

Forty five adult dairy goats were used (30 Alpine and 15 Saanen) in this trial. Estrus was induced with intravaginal sponges impregnated with 60 mg of medroxyprogesterone acetate (MPA), for a period of 9 days. This was combined with a IM treatment of 200 IU of eCG and 37.5 µg of d-cloprostenol, 48 h prior to removal of the intravaginal sponges.

Twenty-four hours after removal of the sponges, goats were randomly assigned to three treatments with 15 animals each. Animals in the T1 treatment (control) received 1 ml saline solution, while the T2 treatment received 5 mg of the luteinizing hormone (LH) and on T3 received 12,5 µg of

GnRH, by intramuscular injection. Image of ovaries as an indicator of ovarian was obtained by transretal ultrasound with the aid of a linear transductor of 5 MHz.

Dairy goats were artificially inseminated with diluted fresh semen ($100x10^9$ spermatozoas per dose straw of 0.5 ml). Intrauterine inseminations were executed 24 and 36 hours following removal of sponges**.** 25 days following AI the first pregnancy diagnosis was performed by ultra-sound, and this was repeated on days 40 and 60.

Data of interval from removal of sponges to estrus, of intravaginal sponges to ovulation, estrus period, interval of the beginning of estrus to ovulation and interval of hormones applications to ovulation were accomplished by ANOVA and the means analyzed by Newman Keuls's test (SNK). Gestation rate and percentage of animals in estrus was compared by using Qui-square test.

Results and Discussion

The astrous response was 100% for the control group, 73.3% for LH treatment group and of 66.6% for the GnRH treatment group, the LH and GnRH groups differed significantly ($P<0.05$)as from the control group. The responses are set out in Table 1. Parameters evaluated did not differ between breeds, therefore data from the two breeds were pooled together. Goats of the control group showed estrus until 49 h, while the goats from the other groups exhibited estrus only 36 hours after sponges removal. Four goats from the treatment with LH and five goats from the treatment with GnRH did not showed estrus. And obvious ????

Table 1 Mean (± SD) interval from intravaginal sponge removal to estrus, duration of the induced estrous period and estrous response outside the breeding season

Treatment	Interval from the removal of sponges to estrus (h)	Estrus period (h)	estrous response (%)
Control	34.8 ± 10.7^a	19.4 ± 9.3	100^a(13/13)
LH	26.5 ± 5.7^b	19.7 ± 7.3	73.33^b(11/15)
GnRH	23.6 ± 7.4^b	20.2 ± 9.4	66.66^b(10/15)

^{a,b} Means, within a column, with different superscripts differ significantly

The use of intravaginal sponges impregnated with 60 mg MAP for a period varying between 9 and 18 days and treated with 200-500 IU eCG applied 48 h or at removal of sponges, associated with or without prostaglandin, has recorded values higher than the 90% estrus induction recorded in this trial (Greyling & van Niekerk, 1990; Baril *et al*., 1993; Menegatos *et al*., 1995; Zarkawi *et al*., 1999; Greyling & van der Nest, 2000; Fonseca 2002).

Pierson *et al*. (2003) using 50 µg GnRH, 24 h after sponge removal, in goats outside the breeding season, also recorded 66.6% estrous response. Administration of LH and GnRH may provoke an inhibitory effect in the ovarian steroidogeneses, as suggested by Sridaran *et al*. (1999), whereas the agonist GnRH initially stimulates the secretion of a larger quantity of gonadotropin and subsequently provokes the desensibilization of the hypophysis and gonads leading to an inhibition of gonadal function and steroidogenesis.

No difference was found regarding estrous lenght for the three treatments 19.7 h. Pierson *et al*. (2003), using 50 µg of recorded an interval from sponge removal to estrus of 39.3 h *versus* 45.7 h, observed for the control group, showing no difference following GnRH is administrated. This result is not in agreement with that observed in the present study which may be due to either breed or nutritional status of the animals. Results of the interval from sponge removal to ovulation for the different treatment groups are setout in Table 2.

Results of this study show a difference ($P < 0.01$) in the use of LH and GnRH, regarding the interval of sponge removal to ovulation, showing a reduction of aproximately 9 h with the use of GnRH. No difference was observed when both treatments were compared to the control group. Cameron *et al*. (1988), using 50µg GnRH, 20 h following intravaginal sponge removal observed 91% of the ovulations to occurr between 36-48 hours after sponge removal.

There was no difference between the interval from injections to ovulation among treatments. The interval from estrus to ovulation increased ($P <0.05$) with the use of LH and GnRH as compared to the

control group. The referred delay in the moment of ovulation may be due to formation of antibodies anti-eCG occoured previously to the present experiment, as suggested by Roy et al. (1999), leading to a postponed pre-ovulation wave of LH and the time of the ovulation. This could be potencialized by GnRH injection.

Gestation rates did not differ among treatments, in spite of the high rate of embryonic loss between day 25 and 40 of gestation for groups receiving LH and GnRH . Causes from this embryonic loss still not elucidated.

Table 2 The mean (± SD) interval from intravaginal sponge removal to ovulation (IRO), interval from the application of the saline solution, LH and GnRH to ovulation (IAO) and from estrus to ovulation (IEO) in goats outside the breeding season.

Treatment	IRO (h)	IAO (h)	IEO (h)
Control	$46.6 \pm 9.3^{a\,b}$	21.3 ± 8.6	11.7 ± 14.1^{a}
LH	52.1 ± 5.1^{a}	26.8 ± 4.1	23.7 ± 5.1^{b}
GnRH	41.6 ± 8.7^{b}	22.3 ± 13.3	22.0 ± 9.8^{b}

[a,b] Means, within a column, with different superscripts differ significantly

Conclusions

The use of LH and of GnRH to induce ovulation estrus outside breeding season goats, did not show satisfactory results which implies in the need of more advanced and detailed researches to determine a better moment for the application of these hormones.

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Body weight and production in Sebian goats

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Abstract

In regard to the economical efficiency of goat production size of animal and number of animals in the herd is of considerable importance. Considering the fact that goats with higher body weight realize higher production, this trait can be used as one of the selection parameters. Bearing in mind that increase of body weight as a consequence has considerably increased food consumption, the issue is raised about optimal body weight of goat resulting in economically efficient production. Objective of this research was to determine optimal body weight of goats in hilly-mountainous region of Stara Planina mountain, in semi-intensive production system (pasture-stable) in relation to realized production. Based on results of research it can be concluded that optimal body weight of investigated goats of Domestic white breed in relation to monitored production parameters was between 40 and 46 kg.

Key words: production performance, body weight, milk, duration of lactation, Domestic white goat, pasture-stable system

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Introduction

Presence of correlation between certain production and other goat traits, as well as other domestic animals, is well known fact. Basically, demonstration and expression of certain trait is more or less induced by presence or demonstration of another trait. It was established that mentioned traits could be influenced by genetic and paragenetic factors, which is determined accordingly. Our research is directed towards evaluation and determination of factors affecting economical significance of goat production, size of single animal and number of animals in one herd. Earlier investigation point that size of animal is of considerable importance not only to the investment in goat production but also to the entire value of realized production. Considering the fact that goats with increased body weight should realize higher production, body weight can be used as one of the selection parameters. However, increased body weight as a consequence has increased food consumption, among other measures, and therefore issue of optimal body weight of goats for production that is economically justified, is raised. Objective of our research was to determine optimal body weight of goats in hilly-mountainous regions, in semi-intensive production system (pasture-stable) in relation to realized production.

Material and Methods

Investigation was carried out on heads of Domestic White goat, in the hilly-mountainous region of Stara planina mountain, on the farm of ZZ »Stočar« in Dimitrovgrad. Semi intensive production system pasture–stable was used, goats were 4.5 years old, in the third lactation and in full physiological growth. Animals included into trial were divided into two groups, those bearing single kids - 176 heads, and those bearing twin kids - 135 heads. Goats bearing 3 or more kids were not included in the experiment.

Body weight of animals in both groups was registered and duration of pregnancy was determined based on the dates of mating and bearing of kids. Also body weight of kids at birth and weaning was registered and kids body weight gain from birth to weaning was calculated (when they were about 120 days old), then daily milk yield and average daily milk yield in third lactation were registered, as well as average duration of lactation. All investigated animals were on the same feeding treatment and housing system during the entire trial period. Obtained data were processed by use of standard statistical methods, including correlation coefficients of body weight of goats and all investigated traits.

Results and Discussion

Results of the correlation between goats body weight and investigated traits are presented in Table 1.

Table 1. Correlation between body mass of goats according to kidding type and production traits

Groups	Single kids	Twin kids
Duration of pregnancy (days)	-0,1243 ^{NS}	-0,1766 ^{NS}
Duration of lactation (days)	0,2543 ^{NS}	0,2667 ^{NS}
Milk quantity	0,0580 ^{NS}	-0,1652 ^{NS}
Body mass of kids at birth		
Female	0,4196**	0,0730 ^{NS}
Male	0,0213 ^{NS}	0,0703 ^{NS}
Body mass of kids at weaning		
Female	0,8151**	-0,3122 ^{NS}
Male	0,4046**	0,2293 ^{NS}
Daily gain from birth to weaning		
Female	0,5064**	-0,2072 ^{NS}
Male	0,4571**	0,0063 ^{NS}

** highly significant (P< 0,01) * significant (P< 0,05), NS/not significant (P >0,05) ^{NS}

Our results indicate the presence of correlation between goats body weight and duration of pregnancy. Although this correlation expressed in both groups of goats with low correlation coefficient is weak and negative, it pointed to the tendency of shortening the pregnancy with the increase of body weight, which is even more so in case of goats with twin kids. 46 kg and 50 kg are considered as optimal body weight of goats for shorter pregnancy period, for goats with single and twin kids, respectively. Correlation between body weights and duration of pregnancy in both groups of goats was negative. In twins it was somewhat more strongly expressed, but in both cases it was very low and not statistically significant (P > 0,05). In our investigation we established that increased number of twin kids was related to body weight of goat dams.

Duration of lactation in case of goats bearing single kids increased with the body weight of 36 kg up to 50 kg, continuously, and this trend of increase was similar also in case of goats bearing twins.

Correlation between body weight and duration of lactation in both trial groups was positive. In case of goats with twin kids it was to some extent more expressed, being however, in both groups weak and without statistical significance (P>0,05).

Analyzing the results of goats milk yield on the basis of their body weight it cannot be said that there is an expressed correlation found, especially in goats which had singles. Lighter goats which had twins had somewhat more milk. However, milk yield variability is strongly expressed, so it can be concluded that the quantity of milk obtained from goats with singles weighing 42 kg, and goats with twins weighing 40 kg could be deemed satisfying. In both groups this trend in milk production is also shown by correlation coefficients, which are in goats with singles positive and low, while in goats with twins it is negative and weak. Both correlations are not statistically significant (P > 0,05).

In regard to the production of kid meat, effect of body weight of dam in regard to bearing twin kids, development of body weight and gain of kids prior to weaning are of great importance. Body weight of male and female single kids demonstrated the tendency to increase with the increase of dam's body weight, especially in case of female kids. This was confirmed by very strong and significant (P< 0,01) correlations. More explicit increase of body weight of female kids was registered in case of dams with 46 kg, and for male kids with 48 kg while outside these values increase of body weight was not explicit. However, in case of twin kids the situation is completely different since dependence on the body weight of dam is very low in comparison with single kids. In case of male kids, weak correlation statistically not significant (P >0,05) was established, and in case of female kids weak and negative correlation statistically not significant (P >0,05).

Analysis of obtained results indicates that body weight of goats is significant for the production in general but not equally for single products.

In domestic literature, there are no data referring to correlation between body weight and production performance, and only few in world literature. Similar results were obtained by following domestic authors *Žujović (1988) and Žujović et al. (1991)* for Domestic white goat and their crosses with Saanen goat, *Memiši et al. (1998)* for Balkan goat breeds, *Mukherjee et al. (1982*) for Indian Gray Bengali goat, *Prasad et al. (1981)* for Indian Black Bengali goat, *Manik et al. (1984)* for Indian Bethal goat and their

crosses with Alpine and Saanen goat, and *Bose et al. (1984)* for Indian Bethal goat. Results of presented research are in accordance with the results of mentioned authors.

Conclusion

On the basis of results obtained for investigated traits in relation to body weight of goats and duration of pregnancy, milk quantity, duration of lactation, kidding type (single or twin kids), body weight at birth and weaning, we can conclude the following:

The optimal body weight in goats in order to obtain optimal body weight of kids was 46-48 kg for goats bearing singles, and 46 kg for goats bearing twins, while in regard to body weight gain this body weight of goat with singles would be 46 kg and 40 kg for goats bearing twins. These data contribute to the relationship between body weight gain and milk yield, because lighter goats have somewhat more milk what enabled their kids to increase faster their body weight (body weight gain).

It is thought that the establishing the goats optimal body weight is very important primarily in selection where goats body mass is taken as one of the key elements.

Based on the results and conclusions of our analysis we think that optimal body mass of Domestic White goat in regard to optimal milk and meat production would be 40 kg and 45 kg respectively, that is, in general, from 40 – 46 kg. Since average body mass in all investigated animals of Domestic White goat was 46, 9 kg, it can be said that this body weight fully satisfies goats optimal production.

Initial data on phenotypic correlations based on relatively large number of goats has enabled us to reach mentioned conclusions and to confirm the presence of more or less determined dependence, that is, correlation between analyzed traits.

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Valorisation of goat milk proteins from lactic cheese whey

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Abstract
As acid goat milk whey is not well valorised, this study was aimed at improving knowledge about its composition and its technological properties. Biochemical analyses showed a high variability in fat and protein composition between acid goat milk whey obtained during the manufacture of five types of goat milk cheeses. This was linked to the technology applied during cheese making and it must be taken into account when evaluating whey protein concentrates (WPC) used to improve texture of products such as 0% fat spread cheeses and firmness of processed cheese.

Keywords: goat milk, acid whey, composition, technological properties
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Introduction
In France, goat milk whey is obtained mainly (90%) from lactic cheese production and is not well valorised. Recent studies have shown that whey proteins from goat milk could have technological properties as useful as those of cow whey (Casper *et al.*, 1999). Institut Technique des Produits Laitiers Caprins (ITPLC) has engaged a study aiming at a better knowledge of composition of acid goat milk whey and functional properties of these proteins in dairy matrices.

Materials and Methods
For chemical characterisation, 130 samples of acid goat milk whey from six enterprises (Nov 2000 - Oct 2001) were analysed. Acid whey obtained during cheesemaking from raw, thermised (Ther) goat milk or pasteurised (Past) goat milk and using curd draining in bags or in moulds were used for the experiment.

For evaluation of the technological properties of acid whey proteins, four types of caprine whey protein concentrate (WPC) were produced: 30 or 80% proteins, from whey obtained from raw (WPCR) or pasteurised (WPCP) goat milk cheese making. After skimming, phospholipid destabilisation and clarification by microfiltration on mineral membranes, wheys were concentrated by ultrafiltration on organic membrane in order to obtain the expected protein concentration (30 or 80%). Concentrates were then dried by external services. Properties of the powders were evaluated in dairy matrices : yoghurt, milk emulsion, process cheese, light spread cheese and cheese foam. All the products were compared to the original ones without WPC but with same total solid (standardisation with skim milk powder) and with another blank made with commercial bovine added WPC.

Results and Discussion
Physicochemical composition of acid goat wheys was characterised. A high variability of casein (CV=142%) and fat (CV = 141%) concentrations was observed. It is directly related to technologies applied, such as the draining method and heat treatment applied on the initial milk. The highest concentration of proteins and fat were found when raw milk was used for cheesemaking and draining in mould was applied.

Concerning the functional properties in dairy systems, WPCP with 30% protein slightly improved water binding capacity of yoghurt and WPC with 80% proteins were efficient for stabilisation of oil in a milk formulation (instead of lecithin). [Data not shown in this paper]. Results were particularly interesting for cheese matrices One percent of added caprine WPC were enough to increase firmness of process cheese, especially WPCP with 80% proteins (Figure 1). In the same way, 1% of WPC pre-treated in water bath at 80°C for 10 minutes, simulating fat matter in low fat spread cheeses, induced disappearance of granular and chalky texture and increased firmness, especially with WPCP (Figure 2). For foam cheese, 1% WPC increased the foaming capacity but decreased foam stability, [Data not shown in this paper], and some technological parameters have to be changed.

Table 1 Physicochemical composition of acid goat milk whey (Mean, *s.d*)

		Heat Treatments			Draining method	
	Total	**Raw**	**Ther.**	**Past.**	**Mould**	**Bag**
Nb samples	n=130	n=40	n=28	N=62	n=51	n=64
Nb enterprise	n = 6	n= 6	n=2	n=6	n=4	n=6
pH	4.50	4.77	4.36	4.38	4.65	4.38
	0.28	*0.29*	*0.12*	*0.20*	*0.31*	*0.19*
Total Solids (%)	5.9	6.2	6.2	5.6	6.2	5.7
	0.7	*0.5*	*0.5*	*0.8*	*0.5*	*0.8*
Fat (g/kg)	1.7	2.6	2.4	0.6	2.8	0.7
	2.3	*2.9*	*2.6*	*1.1*	*2.7*	*1.4*
Proteins (g/kg)	7.9	8.2	9.0	7.2	8.6	7.3
	1.6	*1.4*	*1.2*	*1.5*	*1.4*	*1.4*
Caseins (g/kg)	0.8	0.6	1.2	0.9	1.0	0.7
	1.2	*0.8*	*1.4*	*1.3*	*1.1*	*1.2*
Native WP (g/kg)	7.1	7.6	7.7	6.4	7.5	6.7
	1.5	*1.4*	*0.7*	*1.5*	*1.2*	*1.5*
Lactose (g/kg)	39.4	42.0	39.1	37.7	40.8	38.2
	5.3	*2.9*	*3.5*	*6.6*	*3.6*	*6.2*
Calcium (g/kg)	1.39	1.30	1.40	1.44	1.31	1.45
	0.22	*0.20*	*0.13*	*0.24*	*0.17*	*0.23*

Nb: number of samples; Ther.: thermised goat milk; Past. : Pasteurised goat milk

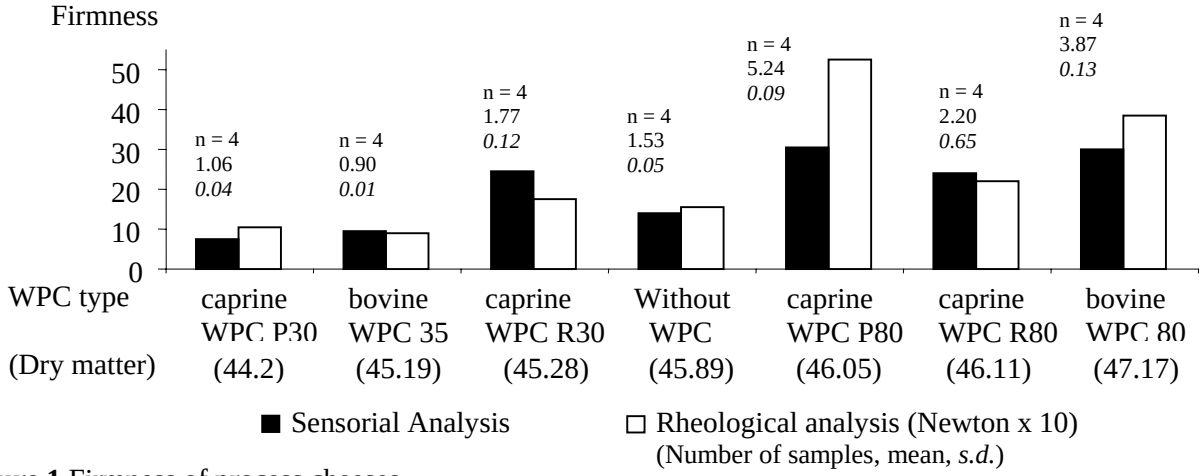

Figure 1 Firmness of process cheeses

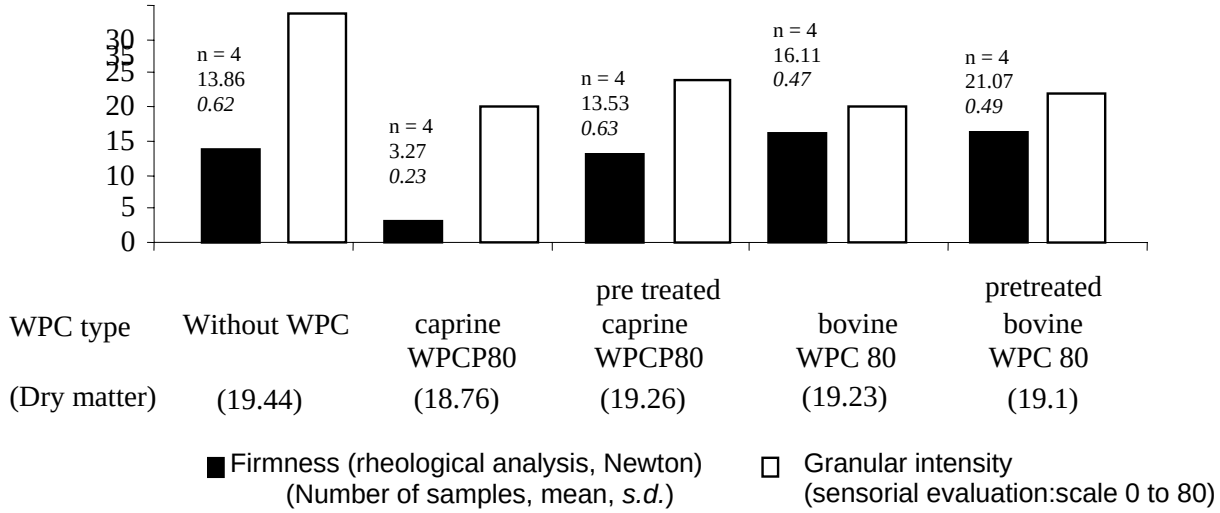

Figure 2 Texture of light spread cheeses (0% Fat)

Conclusion

The caprine WPC gave promising results and may enable the development of new pure goat milk speciality products. These results also showed the variability of acid goat whey composition according to the process applied. This must be taken into account to make use of WPC.

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