Conclusions

Inactivated vaccine is still a promising vaccinal approach to control heartwater. The difficulty for vaccine design is to select the appropriate protective strains with the widest protective effect against regional circulating strains. The choice of a cocktail of strains would be an alternative if any reliable genetic marker related to cross-protection could be defined. Several approaches of genotyping using multi locus analysis (MLST/MLVA) of strains in relation to cross -protection data have been tested and could allow identification of markers associated with cross-protection. Furthermore, it is possible that some of these markers could be involved in the protective immune response.

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Nutritional strategies to control gastrointestinal parasitism in small ruminants

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Traditional control of gastrointestinal parasitism with drugs in ruminants is no longer sustainable. This is because there is an increasing development of gastrointestinal parasite resistance to anthelminic drugs, and the development of this resistance is so rapid and widespread that the efficacy of this mode of chemical control is dramatically challenged. For all these reasons it is now widely accepted that there is a need to develop alternative or complementary methods to control gastrointestinal parasites in ruminant systems and these methods need to be sustainable. The focus of this paper was to consider one, relatively short term such strategy, that has the potential to influence the ability of small ruminants to cope with gastrointestinal parasites: *host nutrition*.

Host nutrition is able to affect gastrointestinal parasitism through various routes. Since one of the main consequences of gastrointestinal parasites is to draw upon host resources, such as loss of plasma, blood, or tissue damage, any increase in nutrient resources will improve the productivity of the host, once the requirements for the above parasite consequences have been met. This amelioration of the detrimental effects of the parasitic infection through nutrition is called *host resilience*. Hosts also attempt to regulate their parasite populations through the actions of their immune system. This function, called *resistance,* manifests as the ability of the host to decrease establishment of parasites in the gastrointestinal tract, delay worm growth, reduce female worm fertility and egg excretion and finally expel existing adult worm populations. Like all bodily functions host immune response requires resources for its functioning and therefore it is to be expected that host nutrition would affect the extent of resistance. The influence of host nutrition on resilience and resistance can be seen as the *indirect* effects of nutrition upon parasite populations. Although there are several nutrients that can potentially enhance host resilience and resistance through nutrition, the majority of the focus has been on supplementation with (metabolisable) protein (MP). This is because this nutrient is often scarce for growing and reproducing small ruminants, due to e.g. consumption of low-quality forages or restricted feeding, at times of high MP requirements for growth and periparturient reproductive functions. The magnitude of these effects would be dependent on the degree of nutrient (MP) scarcity. As such, it would be expected that the largest benefit from protein supplementation would be expected in animals with high nutrient requirements, e.g. multiple-rearing ewes or goats in a relatively poor body condition and in growing lambs or kids with a high growth potential.

However, it has also been shown that host nutrition can have *direct* effects upon parasite populations. The ingestion of specific food compounds or their metabolites may have such direct consequences. Plant secondary metabolites (PSM) fulfil this role since their properties appear to be detrimental on both adult and mature forms of parasites under *in vitro* conditions. Whether and how consumption of forages high in PSM (bioactive forages) is able to affect gastrointestinal parasitism *in vivo* continues to be the subject of scientific investigation. It is likely that the effects of PSM consumption on the host as well as on the parasite need to be taken into account when considering such an approach. As well as having antiparasitic effects, PSM also have negative effects against the host when they are consumed; such effects are usually referred to as anti-nutritional ones. The consumption of PSM-rich plants *per se* by ruminant herbivores can result in reduced intake, weight loss, toxicity and death. In order for parasitized ruminants to benefit from the anthelmintic properties of bioactive plants, the antiparasitic effects should outweigh the anti-nutritional consequences on the performance of the parasitized host. The latter will depend on the severity of the consequences to the host and to the parasite. It will also depend on the duration of exposure to such forages. Parasitized hosts might be able to tolerate short-term negative consequences (e.g. toxicity) if they can attain long-term benefits (e.g. parasite reduction). Consequently, short-term exposure may be one option for including PSM in parasite management schemes. In addition to the PSM route, the excessive consumption or the lack of certain nutrients may alter conditions in the gut environment from beneficial to detrimental and even toxic for parasite survival. Gastrointestinal nematodes identify and select specific locations to reside within the host. It can thus be envisaged that by also influencing the ability of incoming parasites to identify their niche, host nutrition may inhibit their abilities to feed and reproduce. Although these principles have been applied to the control of parasites in non-ruminant animals, they have yet to be applied in ruminant ones.

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When used separately, anti-parasitic efficacy of nutrient (MP) supplementation and bioactive forage consumption is usually considerably lower than what can be achieved through the use of pharmaceuticals, although it has been argued that the latter may not necessarily be required nor desired. It might be therefore beneficial to combine these strategies to control parasites to a greater extent than possible when they are used in isolation. This is because nutrient supplementation and PSM consumption affect differently components of parasite life cycle (epidemiology) and benefit hosts differently at different productive stages (e.g. growing vs. lactating small ruminants). This principle has just been applied in temperate systems of production with greatly promising consequences. The strategy used was the supplementation of ewes with MP and the supply of chicory as forage to their lambs, and resulted in substantially reducing the antiparasitic drug input into the system than was achieved by using either of the two strategies on its own.

The issue is whether the principles developed above could be applied to control parasites in small ruminant systems of production in the tropics, especially because the option of nutrient supplementation might not always be available. When devising such nutritional strategies one should take into account the availability of local resources on the one hand and both the antiparasitic and anti-nutritional properties of local forages on the other. Only then alternative strategies can be implemented and incorporated into local systems of production with a high degree of success. The final part of this paper will concentrate on this issue.

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Epizootiology of gastrointestinal strongyles in Pelibuey ewes in a silvopastoral system under a selective treatment program

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Introduction

The search of solutions to parasite infestations is one of the main present challenges in sheep production systems, where the occurrence of resistance to anthelmintics is increasingly frequent (Papadopoulos, 2008). The FAMACHA© system seems to be an appropriate parasite control tool when resistant sheep strongyles infestations occur, if used as a part of a comprehensive integrated parasite control strategy.

Material and methods

For three years an experiment was carried out in the research areas of the Grass and Forage Research Station "Indio Hatuey", Matanzas, Cuba. In order to perform the research strategy, fifty-seven Pelibuey ewes were treated under a parasite control scheme based on suppressive treatments in the mid dry season and the beginning of the mating campaign, with the application of the FAMACHA© system scheduled for the rest of the year. The ewes under the scheme received a supplementary feed source at the mating season, the last third of pregnancy and the first thirty days postpartum. Experimental data regarding the fecal egg count (FEC), haematocrit (PCV), body condition score (BCS) and the color of the ocular mucosa with the FAMACHA© card were determined on an individual monthly basis. Ewes grazed on a silvopastoril system within a rotational system of *Leucaena leucocephala*. The SPSS® software was used for data processing. Mean differences were assessed through an ANOVA analysis.

Results

Three years after the implementation of the selective treatment strategy, a stability of the parasite population was observed. *Haemonchus* spp remained as the principal parasite affecting the herd, which is confirmed as the main health problem of sheep in the region (Arece *et al*., 2004). The selective drenching schedule did not allow other species to occupy its ecological niche. Ewes were found to be significantly ($P \leqslant 0.01$) infested in the dry season, which coincides with previous studies carried out before the adoption of the present parasite control strategy. The global herd infestation was low since 59% of the herd showed FEC lower than 300 epg, and only 26% was higher than 1000 epg. In addition to this, about 83% of the flock, on the average, was classified as "A" or "B": the FAMACHA© color card. The increase of the global FEC (with respect to previous years) did not affect their BCS because most of the animals had been diagnosed as having moderate to slight infestation levels. In contrast with a previous study carried out in this same flock, the non-pregnant ewes were the most infested ($P \leqslant 0.01$) and the drenching program about the lambing date interfered on the periparturient rise effect.

Conclusions

As expected, the use of FAMACHA© allowed for a drastic reduction in anthelmintics used to control infestations in ewes. The selective drenching scheme did not affect the epizootiology of strongyles infestation.

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