Evaluation of initial live weight in fattening bulls fed diets based on *Panicum maximum*, peanut (*Arachis hypogaea*) cuticles and a protein-energy supplement

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The use of peanut cuticles, *Panicum maximum* forage and a protein-energy supplement (MUSS-Lactibiol) was evaluated in an integral diet for bulls starting fattening. Twenty seven stabled bulls were utilized divided in four groups (treatments A, B, C and D) with an average initial live weight of 282, 327, 364 and 422 kg ± 4 kg, respectively. Diets in the formula (% humid basis) consisted of *P. maximum* forage, 89, peanut cuticles, 7 and MUSS-Lactibiol, 4. The concentrate-forage relationship (% dry basis) was 21:79, with ME concentration of 10.0006 MJ.kg DM^{-1} and CP of 11 %. DM content was 48 %. A simple classification design with the previously mentioned treatments was employed. An analysis of variance was applied for the means of the productive indicators. The highest ADG (1.194 kg) was obtained in animals with an initial LW of 327 kg, although these did not differ from those starting with a LW of 282 kg and ADG of 1.076 kg. ADG decreased as LW increased ($R^2 < 0.73$). ADG in the group of 364 kg was 937 g and decreased as LW increased ($R^2 = 0.71 < 0.05$), DM, ME and CP conversion increased with R2 value of 0.79 for these nutrients. In the group of animals of 422 kg, ADG was not affected and maintained constant until finishing the fattening with an average of 862 g. There was no difference from the group of 364 kg indicating that in high fiber diets, animals starting with LW higher than 350 kg, DM consumption stabilizes limiting ADG to values lower than 1 kg. Conversions in both groups of higher initial LW were worst than in those of lower LW. Data obtained demonstrate that with a 21:79 concentrate-fibrous feed relationship an ADG close to 1 kg is feasible. The forage contributes 78 % DM, 58 % CP and 65 % ME making possible the development of meat production technologies with agro-industrial fibrous residues.

Key words: *peanut cuticles, forage, fattening, stabled, MUSS-Lactibiol*

Meat production in Nicaragua, as in other Central America countries, is structured by long cycles. It is mainly based on animal consumption of grasses and lacks of integral technologies allowing the utilization of local feeds of these tropical regions for beef production.

Castellón *et al.* (2014) demonstrated the possibility of using peanut crop wastes as hay, on incorporating it in 69 % of the dry matter (DM) of the components in an integral diet for obtaining average daily gains (ADG) of live weight (LW) ranging between 0.961 and 0.835 kg, according to the initial LW of stabled bulls.

The enriched peanut cuticle is produced from a physicochemical process from which the grain cuticle is removed. Its centesimal composition varies in function of the industrial process and can reach to contain high CP levels (25 %) and fat (35 %), according to Castellón *et al.* (2014). On its incorporation to integral diets with high fibrous forage levels could contribute to the CP and ME contents of these diets for achieving high forage degradability, if the rumen microorganisms are supplemented with the adequate nutrients for attaining this effect according to Elías (1983) and Valenciaga and Chongo (2004).

In turn, the inclusion of agricultural additives, also known as probiotics, according to FAO (2012) could increase with higher efficiency the productive response in these animals (Elías and Herrera 2008).

The objective of this study was to evaluate in stabled bulls with different initial live weight, the use of diets based on *P. maximum* forage, peanut cuticle and a protein-energy supplement (MUSS-Lactibiol) as future technology for bull fattening in Nicaragua.

Materials and Methods

Twenty seven bulls of different Zebu x Criollo crossings in which the Zebu proportion predominated in the herd were used. Animals were individually weighed for their grouping to four treatments: A) average initial LW of 282 kg, from animals of 250 to 300 kg; B) initial LW of 327 kg, from animals of 300 to 350 kg; C) initial LW of 364 kg, from animals of 350-400 kg; D) initial live weight of 422 kg, from animals of 400-450 kg for evaluating the effects produced by the initial LW on the variables related to the nutrition and productivity of the animals during fattening. Animals were separated in stabled lots and a diet (% in humid basis) of *P. maximum* forage, 89; peanut cuticle, 7 and MUSS-Lactibiol, 4 was supplied. The concentrate:forage relationship (% dry basis) was 21:79 with ME concentration of 10 MJ.kg DM^{-1} and CP of 11 %. The DM content was 48 %.

Ten per cent of the consumption in fresh form was supplied weekly for not limiting the intake. Bulls were maintained stabled 83, 78, 78 and 30 d, respectively, until reaching an average of 435 ± 7 kg LW. For course feeds, 10 % more was supplied weekly, in fresh form, for not limiting its intake, except for the activator whose distribution was controlled. Animals were wormed and weighed since the first day of the trial. There was no adaptation period to the diets and they were weighed at the end of the experiment. In each group, consumption was weekly measured for correcting feed supply. A simple classification design with four treatments was used and an analysis of variance was carried out for the means of consumption of each feed, LW gain and ME, DM and protein intake. Hart's (1971, cited by Elías 1983) equation was used for determining de metabolizable energy (ME) concentration of each coarse feed. CP and DM of all feeds were determined according to AOAC (1995). The INFOSTAT program, version 2001 was utilized for the statistical processing.

The MUSS-Lactibiol is a biologically active product of the MEBA line (Elías and Herrera 2008), containing high population of yeasts and bactobacilli and their metabolites . It functions as a probiotic, capable of producing considerable amounts of organic acids of short carbonated chain; also includes the necessary nutrients for the growth of the rumen microorganisms and for fiber use.

Results and Discussion

Table 1 shows that there were differences in the initial LW of the animals in the different treatments, as initial LW at the beginning of the experiment was increased, with differences between the treatments of lower to higher LW of 45, 37 and 58 kg, respectively.

Final LW increased as initial LW increased although there was no significant difference between the two latter treatments, with differentiated increase between them from 49, 18 and 10 kg in 83, 78, 78 and 30 d, respectively for achieving the final LW obtained. Total LW gain at the end of the experiment was 89, 93, 74 and 26 kg, respectively. The highest ADG was obtained in the animals with initial LW of 300-350 kg, although these did not differ from those starting with LW of 250-300 kg. In ADG expressed in g.kg LW^{-1} the two groups of lower initial LW, gained more than the two groups of higher initial LW.

Although there was higher consumption of DM and remaining components of the diet in animals of higher initial LW, differences obtained regarding animals of lower LW were of slight importance, since on expressing consumption related to kg.LW^{-1} they were constant for both treatments (table 1), regardless that animals grew in the time. Certainly this will be reflected in daily LW gain through the negative direct relationship (R^2 = 0.48 ns; 0.73 $P < 0.05$; 0.71 $P < 0.05$; 0.25 ns), respectively, obtained on increasing initial LW: to higher live weight, lower ADG (table 2). Therefore, for fattening with diets of low energy concentration and high forage proportion, it is necessary to find the adequate LW.

Concerning feed conversion, animals starting with LW of 250-300 kg and of 300-350 kg consumed less DM, CP and ME than those starting with LW of 350-400 kg and 400-450 kg (table 1). On calculating the mean in both groups of lower LW, as well as in both of higher LW and determining the differences in the conversions between them, groups of high LW needed

Table 1. Live weight gain, consumption and conversion in stabled bulls fed a ration based on forage (*P. maximum*), peanut cuticle + MUSS-Lactibiol

Variables	Treatments, kg LW								
	250-300	±SE	300-350	±SE	350-400	±SE	400-450	±SE	Sig.
Initial LW, kg	282.0[a]	4.48	327[b]	4.15	364.0[c]	4.15	422.0[d]	4.15	***
Final LW, kg	371.0[a]	3.79	420.0[b]	3.51	438.0[c]	3.51	448[c]	3.51	***
ADG, g	1076.0[ab]	80.0	1194.0[b]	70.0	937.0[a]	70.0	862.0[a]	70.0	*
ADG, g-kg LW^{-1}	3.3b	0.21	3.2[b]	0.20	2.3[a]	0.20	1.98[a]	0.20	***
Consumption									
Total consumption, DB, kg	8.23[a]	0.09	9.15[b]	0.08	9.75[c]	0.08	9.9[d]	0.08	***
Forage	6.47[a]	0.06	7.13[b]	0.06	7.60[c]	0.06	7.70[c]	0.06	***
Peanut cuticle	1.15[a]	0.01	1.28[b]	0.009	1.34[c]	0.009	1.38[d]	0.009	***
MUSS-Lactibiol	0.70[a]	0.003	0.73[b]	0.003	0.76[b]	0.003	0.80[c]	0.003	***
CP, g	963.0[a]	10.0	1065.0[b]	9.0	1126.0[c]	9.0	1154.0[d]	9.0	***
ME, MJ	82.7[a]	0.92	91.1[b]	0.87	96.5[c]	0.87	99.1[c]	0.87	***
g DM.kg LW^{-1}	25.2		24.3		24.3		23.0		
g LW.kg LW^{-1}	2.9		2.8		2.8		2.7		
KJ ME.kgLW^{-1}	60.7		58.3		57.6		54.8		
Conversion									
kg DM.kg LW^{-1}	7.93[a]	0.77	7.78[a]	0.71	10.6[b]	0.71	11.4[b]	0.71	***
g CP.kg LW^{-1}	895.0[a]	86.0	892.0[a]	80.0	1201[b]	80.0	1338[c]	80.0	***
MJ.ME.kg LW^{-1}	76.9[a]	7.7	75.6[a]	7.1	102.8[b]	7.1	114.9[b]	7.1	***

Students t test P< 0.05 was used
***P < 0.001 *P < 0.05

Table 2. Values of R^2, according to analysis of linear correlation between productive indicators and initial weight.

Initial weight	Intake				Conversion		
	ADG, g	total DM, kg	total CP, g	ME, MJ	kg.DM.kgLW^{-1}	ME.kgLW^{-1}	CP.kgLW^{-1}
250-300 kg	0.48	0.56	0.56	0.56	0.63	0.63	0.51
R^2	ns	ns	ns	ns	ns	ns	ns
Sign.							
300-350 kg	0.73	0.76	0.77	0.76	0.8	0.8	0.8
R^2	*	*	**	**	**	*	**
Sign.							
350-400 kg	0.71	0.16	0.18	0.17	0.79	0.79	0.79
R^2	*	ns	ns	ns	**	**	**
Sign.							
400 - 450 kg	0.25	0.91	0.91	0.91	0.33	0.33	0.33
R^2	ns	***	***	***	ns	ns	ns
Sign.							

* P < 0.05 ** P < 0.01 *** P < 0.001

3.14 kg DM, 126 g CP and 32.6 MJ of ME more than those of lower LW for gaining 1 kg LW daily. This means that on increasing LW of the animals there was a worsening of the efficiency of utilization of these nutrients.

For attaining ADG between 0.9 and 1.2 kg, the NRC (1984) propose that forage inclusion (%) in the diet must be between 15-50 % compared to that of this experiment, which was 78 % (figure 1), with energy concentration of 10 MJ of ME, on considering the MUSS-Lactibiol and the peanut cuticle as a concentrate. This justifies that the utilization efficiency of ME is directly related to the decrease in the participation of fibrous feeds in the diet: to greater forage participation in the diet (%), lower efficiency. On comparing the NRC (1984) tables for animals of lower and higher initial LW, the ME and CP consumed by the animals in this study are in excessive amounts regarding the recommendations of this institution, which provoked a decline in conversions (table 2). It is contrasting that for achieving the same ADG, obtained with both groups of lower initial LW, NRC recommends a ME concentration of approximately 3.0 Mcal, equivalent to 12 MJ, while the diet of this experiment was of 2.39 Mcal, equivalent to 10 MJ. This could have also influenced on the worsening of the conversions obtained.

The excess of CP was also reflected in the g of CP consumed per Mcal of ME relationship which in this experiment was of 48, while NRC (1984) recommends a relationship of 43. Something similar will occur if data obtained in animals starting with higher LW are compared, since ADG in the 350-400 kg group decreased as LW increased (R2 = 0.71 P< 0.05). Since there was no increase in the daily consumption of DM, ME and CP (table 2), DM, ME and CP conversion increased, with R^2 value of 0.79 P < 0.01 for these nutrients.

In the group of animals of 400-450 kg, ADG was not affected and maintained constant until finishing the fattening, with an average of 862 g (table 2) and ADG, g.kg LW^{-1} of 1.98, not differing from the group

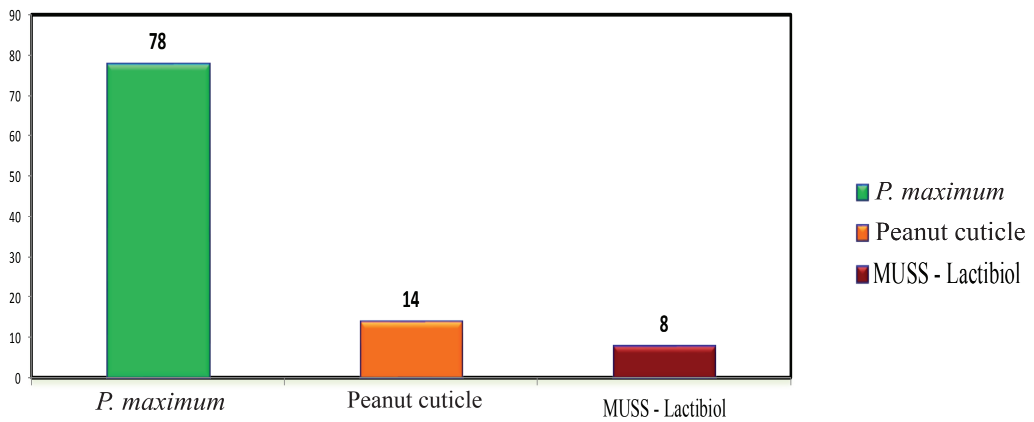

Figure 1. Contribution in DM (%) of diet components

of 350-400 kg. This indicates that, in high fiber diets, animals starting with LW higher than 350 kg, DM consumption stabilizes, limiting ADG to values lower than 1 kg and also determines the worsening of conversions. On comparing these results to those of NRC (1984), the group of 400-450 kg consumed similar DM and ME but 284 g more of CP. It must be indicated that forage inclusion and ME concentration in the diet of NRC (1984) is of 45-55 % and 2.60 Mcal of ME, respectively, while for this group was of 78 and 2.39 Mcal of ME, equivalent to 10.09 MJ, respectively.

Despite the beneficial effect of nitrogenous supplementation to bovines fed poor quality pastures or forages (Elías 1983, Ortiz 2000, Delgado 2002, Díaz and Padilla 2003, Ruiz *et al.*, 2003, Ramos 2005 and Elías *et al.* 2006), LW gains obtained by the above mentioned authors were lower than hose of this study. Possibly this is due to the fact that the MUSS-Lactibiol, together to the cuticle, supplied sufficient peptides and amino acids for fulfilling the statement of Elías *et al.* (2006): "when animals in pastures or forages, with LW concentrations of approximately 8 %, are not supplemented with sufficient rumen degradable protein, the concentration of peptides and free amino acids in this organ is zero and the concentration of volatile fatty acids lowers." Thus, the conversion of the apparent digestible energy is limited, affecting energy conversion of these fibrous feeds. Moreover, together with this, it is must likely that the MUSS-Lactibibiol has also supplied the trace elements, vitamins and other nutrients which, according to Elías (1971 and 1983) stimulate ruminal cellulolysis and protein synthesis from NPN, and thus, voluntary intake. Also, this has been reported by other authors (Ortiz 2000, Ramos 2005 and Krause *et al.* 2013). Yeasts contained in the MUSS-Lactibiol could also stimulate the cellulolytic bacteria and fiber digestibility, as reported by Kamra and Agarwal (2004), Mao *et al.* (2013) and Vyas *et al.* (2014).

P. maximum contributed 78 % of the DM, 5 % CP and 65 % ME. In turn, the peanut cuticle participated with 15 % of the DM, 27 % CP and 25 % of the energy, while the MUSS-Lactibiol contributed 8 % of the DM, 15 % CP and 10 % ME. In the diet there was no traditional amylaceous (cereals) or protein (soybean, fish meal, sunflowerseed meal, cottonseed meal) sources.

This could be related to the possibility of securing a productive response above one kilogram of ADG, obtained in this study from *P. maximum* forage with peanut cuticle and MUSS-Lactibiol in integral diet, provided animals start fattening with LW between 250 and 350 kg. In turn, with high fiber diets, animals starting fattening with LW higher than 350 kg stabilize DM consumption, limiting ADG to values lower than 1 kg, determining also the worsening of conversions.

It is concluded that for obtaining ADG higher than 1.200 kg, it would be necessary to increase energy concentration of the diet through the inclusion of amylaceous energy sources, fermentable or not in the rumen, or with non-degradable in the rumen protein sources or with both.

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