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Performance of three breeds of sheep as affected by varying levels concentrate supplementation under feedlot production system in Nigeria

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Abstract

To assess the impact of feeding concentrate at varying levels on feed intake and body weight increase in rams, a 2 × 3 factorial design was used. Ten rams from the Balami, Uda, and Yankasa breeds of sheep, ranging in age from 24 to 36 months, were utilized. Their average weights were 34.20 ± 3.5 kg, 35.35 ± 3.6 kg, and 31.80 ± 3.5 kg, in that order. They were given Digitaria smutsii (Stent) hay supplemented with concentrate at a rate of 1% or 2% of their body weight. Following a 14-day period for diet adjustment, the trial lasted 90 days. Everyday records of each animal's basal and supplemental concentrate feed intakes were made, and the Statistical Analysis System (SAS) was used to analyze the live weight measurements every two weeks. The breed effect result revealed that compared to Yankasa, which had an average daily feed intake of 1.28 kg, a final weight gain of 42.03 kg, and an average daily weight gain of 0.11 kg, respectively, Balami and Uda had significantly (P<0.05) higher values for average daily feed intake (1.32 and 1.34 kg), final weight gain (48.90, 48.60 kg), and average daily weight gain (0.16 and 0.15 kg). Rams supplemented with concentrate at a level of 2% of body weight outperformed animals fed at 1% of body weight, according to the same amount of concentrate supplementation. Additionally, the interaction effect revealed that Yankasa had the lowest feed conversion ratio (P>0.05) and weight gain (P>0.05), whereas Balami had the highest. In conclusion, feeding D. smutsii hay supplemented with 2 percent body weight concentrate can be a productive way to grow and fatten rams in feedlot production systems without having a negative impact on their productivity throughout a twelve-week feedlot period. Furthermore, the identified interactions between concentration level and breed enable better practical options for growing rams on D. smutsii hay.

Keywords: Breed, Confinement, Feed intake, Rams, Weight gain

Performance de trois races de moutons en fonction de différents niveaux de complémentation en concentrés dans un système de production en engraissement au Nigéria

Résumé

Pour évaluer l'impact de l'alimentation en concentrés à différents niveaux sur la consommation alimentaire et l'augmentation du poids corporel des béliers, un plan factoriel 2 × 3 a été utilisé. Dix béliers des races Balami, Uda et Yankasa, âgés de 24 à 36 mois, ont été utilisés. Leurs poids moyens étaient respectivement de 34,20 ± 3,5 kg, 35,35 ± 3,6 kg et 31,80 ± 3,5 kg. Ils ont été nourris avec du foin de Digitaria smutsii (Stent) complété par des concentrés à un taux de 1 % ou 2 % de leur poids corporel. Après une période d'ajustement de 14 jours, l'essai a duré 90 jours. Des enregistrements quotidiens de la consommation alimentaire de base et de complément des animaux ont été effectués, et le système d'analyse statistique (SAS) a été utilisé pour analyser les mesures de poids vivant toutes les deux semaines. Les résultats de l'effet de race ont révélé qu'en comparaison avec Yankasa, qui avait une consommation alimentaire quotidienne moyenne de 1,28 kg, un gain de poids final de 42,03 kg et un gain de poids quotidien moyen de 0,11 kg, respectivement, Balami et Uda avaient des valeurs significativement (P<0,05) plus élevées pour la consommation alimentaire quotidienne moyenne (1,32 et 1,34 kg), le gain de poids final (48,90 et 48,60 kg) et le gain de poids quotidien moyen (0,16 et 0,15

kg). Les béliers supplémentés en concentrés à un niveau de 2 % de leur poids corporel ont surpassé ceux nourris à 1 % de leur poids corporel, selon la même quantité de supplémentation en concentrés. De plus, l'effet d'interaction a révélé que Yankasa avait le ratio de conversion alimentaire le plus bas (P>0,05) et le gain de poids (P>0,05), tandis que Balami avait le plus élevé. En conclusion, nourrir avec du foin de D. smutsii supplémenté avec 2 % de concentré par rapport au poids corporel peut être une manière productive d'élever et de engraisser des béliers dans des systèmes de production en engraissement sans impact négatif sur leur productivité tout au long d'une période de douze semaines. De plus, les interactions identifiées entre le niveau de concentration et la race permettent de meilleures options pratiques pour l'élevage de béliers sur du foin de D. smutsii.

Mots-clés : Race, Confinement, Consommation alimentaire, Béliers, Gain de poids

Introduction

It is commonly known that sheep farming is economically significant in Africa's rural, urban, and peri-urban areas (Baah, 1994; Ajala *et al*., 2008). With the rising number of lambs produced for slaughter over time, driven by the expanding demand for mutton, necessitated the enhancement of the exploratory procedures (Parente *et al.*, 2016). It has been observed that increasing the amount of feed provided in a feedlot improves sheep development and meat yield (Pasha, 2006).

According to a number of study findings, an animal's ability to grow depends on its genetic potential as well as how much of its environment—especially its diet—allows it to realize that potential (Oddy and Sainz, 2002). There have been reports on the effects of genotype on sheep performance (Boujenane *et al.*, 2015), genotype and feeding system (Santos-Silva *et al*., 2002), and genotype and feeding levels (Fozooni and Zamiri, 2007). However, it is unclear how differently different genotypes may respond to varying feed levels.

To identify a prospective breed and establish different management options for the various genotypes of sheep, it is necessary to understand the comparative growth potential of different sheep genotypes and their response to varying food levels (Shirima *et al.*, 2014). Research data on the right amount of feeding to enhance development, nutrient use, and revenue realization in Nigerian sheep breeds is scarce. Therefore, the aim of this study was to ascertain how feeding concentrate at varying doses affected the intake and growth performance of sheep from the Balami, Uda, and Yankasa breeds.

Materials and methods

Location of the study

The National Animal Production Research Institute, Shika-Zaria's Experimental Unit, Small Ruminant Research Program was the site of the study's 2017 conduct. At a height of 640 meters above sea level, Shika is located in the Northern Guinea Savannah Zone of Nigeria, between latitudes 11o 8′ 19.56″N and longitudes 7o 45′ 51.22″E. The rainy season, which begins in April or May, settles in June, and concludes in October, is what defines the zone. 1100 mm of rain falls on average each year. April records the highest temperature range of 27 to 35.0°C, while December to February has the lowest mean minimum temperature of 11.5°C and the highest relative humidity of roughly 72%. The start of the dry season is marked by harmattan, a spell of chilly, dry weather that lasts from October to January. From March to May, dry, hot weather follows the harmattan.

Animals and Experimental Design

The study evaluated the impact of supplementing Digitaria smutsii hay as a basal diet with concentrate fed at 1 or 2% of body weight on feedlot performance. Thirty rams, representing the Balami, Uda, and Yankasa breeds, were purchased from open markets at Achida and Giwa in Sokoto and Kaduna States, Nigeria. The rams' average age ranged from 24 to 36 months. Their average live weight was 34.20 ± 3.5 kg, 35.35 ± 3.6 kg, and 31.80 ± 3.5 kg for the Balami, Uda, and Yankasa, respectively. The rams were assigned at random

to one of the two concentrate levels after being weighed and balanced.

Experimental diets

The base meals for the experiments were made of *D. Smutsii* hay, often known as woolly finger grass. As indicated in Table 1, the supplement consisted of a combination of bone meal (2.50 %), cottonseed cake (39.19 %), maize (37.87 %), maize offal (18.94 %), and table salt (1.50 %).

Management of animals

The rams were ear-tagged and placed in confinement for 30 days prior to the start of the trial. They were soaked in an acaricide to kill external parasites and covered in a broad range anthelmintic to kill internal parasites during the quarantine period. As a precaution against potential infection, long-acting antibiotics were also applied to them. After that, their original weights were determined by weighing them. After that, they were kept in separate feeding pens, given *D. Smutsii* hay, and given concentrate supplements equal to either 1% or 2% of their body weight.

The concentrate combination was given to the rams at the beginning of each feeding session, and they were given 30 to 45 minutes to eat it before the basal meals were made available to them at all times in individual troughs inside the pens. Water was provided *ad libitum* in 10-liter plastic pails was changed daily. The rams were weighed every two weeks following a fourteen-day initial adjustment phase, and the amount of feed provided was modified based on the adjustment.

Chemical analysis

To assess the dry matter (DM), ash, and nitrogen (N), the dried samples of the feeds (concentrate and hays) were ground using a Christy and Norris mill and passed through a 1 mm sieve. The samples were then further dried at 105 ℃ for an hour, in accordance with the AOAC (2000) technique. The calculation of crude protein (CP) involved multiplying N by 6.25. Both acid detergent fiber (ADF) and neutral detergent fiber (NDF) were analyzed using the method of Van Soest *et al.* (1991) methodology. The feces samples were also subjected to chemical analysis in accordance with AOAC (2000) procedures. The amount of acid detergent fiber (ADF) and neutral detergent fiber (NDF) in the feces was also measured using Van Soest's (1991) methodology. The Kjeldahl method was used to determine the nitrogen content in urine samples (AOAC, 2000). The following formula was used to calculate the nitrogen retention and digestibility coefficient:

$$\textit{Apparent digestibility (\%)} = \frac{\textit{(Nutrient intake} - \textit{nutrient in feces)}}{} \times 100$$

Nutrient intake

The feed intake of the rams was restricted to just 90 % during the seven days' collection in order to reduce wastage and minimize orts.

Statistical analysis

All data were subjected to a two-way analysis of variance (ANOVA) of the Statistical Analysis System software version 9.2 (SAS, 2002) according to the following model: $Y_{ijk}= \mu+ a_i + b_j + ab_{ij} + e_{ijk.}$ Where; Y_{ijk} = dependent variable, μ = Overall mean, a_i = fixed effect of the i^{th} concentrate (i=1, 2), b_j = fixed effect of the j^{th} breed (j=1, 2, 3), ab_{ij} = interaction effect of breed and hay type, e_{ijk}= random error. Duncan's Multiple Range Test (Duncan, 1955) was used to separate mean differences, with the level of significance declared at $P<0.05$.

Results

Chemical composition, total lipid percent, and, fatty acid composition of experimental feeds.

The chemical composition of hay (*D. smutsii),* maize, maize offal, and cottonseed cake as well as that of the concentrate are presented in Table 1.

Feed intake and body weight changes of Balami, Uda, and Yankasa rams fed D. smutsii hay supplemented with concentrate at different levels

Table 2 displays how breed affects feed intake and changes in body weight in rams given D. smutsii hay supplemented with concentrate at 1 or 2% body weight. For every parameter examined, the effects of Balami and Uda were comparable, although their values were much ($P<0.05$) higher than those of Yankasa rams. The impact of the rams' concentration level on their performance is displayed in Table 3. All measured parameters were significantly ($P<0.05$) impacted by the amount of concentrate, with the exception of metabolic weight and consumption per metabolic weight. Rams fed at 2% of body weight exhibited greater values than those fed at 1% of body weight.

The breed and concentration level interaction is seen in Table 4. When it came to their daily feed intake, Balami rams given concentrate at a rate of 2% of body weight performed better than those fed concentrate at 1% of body weight. Rams fed concentrate at 2% of body weight had significantly higher values than those fed concentrate at 1%, a pattern that was also observed in the Uda and Yankasa breeds.

Balami rams fed concentrate at 2 percent of body weight had considerably ($P<0.05$) greater final weight values than Balami rams fed concentrate at 1 percent. The average daily weight gain and weight gain of Balami rams fed the concentrate at 2% of body weight were substantially ($P<0.05$) higher than those fed the concentrate at 1% of body weight. Uda and Yankasa breeds showed a similar pattern, with rams given concentrate at 2% of body weight recording considerably ($P<0.05$) higher values of these parameters than rams given concentrate at 1% of body weight. Balami rams fed concentrate at 2% of body weight had a considerably ($P<0.05$) greater feed/gain ratio than rams put on concentrate at 1%. Similarly, rams from Uda and Yankasa that received a concentrate supplementation at a rate of 2% of their body weight showed noticeably ($P<0.05$) greater values than rams that received a concentrate supplementation at a rate of 1% of their weight.

Discussion

Chemical composition, total lipid percent, and fatty acid composition of experimental feeds

The concentrate's and *D. smutsii* hay's basal diet's chemical compositions were enough to meet the nutritional needs of growing and fattening sheep. While the CP value was lower than the 9.6% reported by the same author, the DM value for maize offal obtained in this investigation was higher than the 89.9% DM reported by Ayoade (1989). The variations in the types, soil fertility, and habitats of the maize could account for the discrepancies in the CP values between the maize offal utilized in previous investigations and the later. Higher CP values of 12.7% and 12.69% were recorded by Olorunnisomo *et al.* (2006) and Idowu (2011), respectively. NDF and ADF values exceeded ADF and NDF values by 21.64% and 26.3%, respectively. The EE and OM levels above the 4.40%, 65., and 05% that Madziga *et al.* (2013) reported for EE and OM, respectively. The value of ash, however, was less than the 26.7% that Lamidi *et al.* (2008) reported.

The DM, OM, CP, and EE values of the cottonseed cake utilized in this investigation were lower than those employed by Lamidi (2005) and Lamidi et al. (2007), which were 92.99, 88.01, 30,.88, and 11.05%, respectively. Nonetheless, the ADF and ash values, as reported by Lamidi (2005) and Lamidi *et al.* (2007), were quite close to 42.35 and 4.98%, respectively.

While the values of 5.86, 68.89, and 8.82 percent for CP, NDF, and ash, respectively, were higher than those reported by Lamidi (2005) but comparable to the report by Madziga et al. (2013), the values of DM, CF, EE, OM, and ADF, respectively, for D. smutsii were lower than the 98.84% DM, 44.84% CF, 6.85% EE, 90.75 OM, and 48.75% ADF reported by Lamidi (2005) and Yashim (2014). The D. Smutsii employed in this study had DM, OM, ND, and ADF values that were lower than those reported by Goska *et al.* (2016), 96.13, 89.33, 7110, and 55.04. However, the results for CP, E, E, and ash were in line with previous

findings (Lamidi, 2005; Madziga *et al*., 2013; Goska *et al.*, 2016).

The variations observed in the values of the chemical composition of the feed ingredient in the current study as compared to those in the previous reports may have been due to differences in the year of production, method of processing, and difference in the laboratory analyses of these materials.

Feed intake and body weight change of Balami, Uda, and Yankasa rams fed D. smutsii hay supplemented with concentrate at different levels

Table 3 demonstrates that average daily weight gain (ADG) and average daily feed intake (ADFI) varied between the breeds. Yankasa was lower in value than Balami and Uda, who had similar values. The results of concentrate feeding show that, in comparison to rams fed at 1% of body weight, rams fed concentrate at 2% of body weight had higher average daily feed intake and weight increase. Balami rams fed concentrate at 2% of body weight had higher ADFI and ADG than Balami rams fed concentrate at 1% of body weight, according to the interaction impact of breed and degree of concentrate feeding. A comparable finding was that the ADFI and ADG of Yankasa and Uda rams given concentrate at 2% of body weight were higher than those of the rams fed concentrate at 1% of body weight.

Breed variations account for Balami's increased intake and utilization of the diet compared to the other two breeds, and this finding validates a report by Crouse *et al*. (1981) that found genetic diversity in the growth rate of American sheep breeds. The rams were encouraged to eat more hay by feeding concentrate at 2% of body weight; as a result, the Balami rams gained more weight than the Uda and Yankasa rams due to higher roughage consumption and overall feed intake.

The variations in the size and volume of the reticulorumen among the three breeds may be reflected in the variations in their total DM intake (% BW) (Kyriazakis and Oldham, 1997). Numerous researchers have observed that the reticulorumen volume of ruminants controls their potential feed intake physically (Kyriazakis and Oldham, 1997; Fisher, 2002). Getahun (2001) found that the weight of the empty reticulo-rumen in goats is positively correlated with the level of consumption. Breed effect, which has previously been documented by Tsegay *et al.* (2013) in Ethiopian sheep breeds, may be linked to the notable variation in total DM intake. According to Pulina *et al*. (2013), sheep's voluntary feed intake has a heritability (h2) value of 0.11 to 0.66, indicating that it is highly heritable and transferred from parent to offspring.

The greater CP consumption may have been the cause of the variations in ADG between concentration levels. This facilitated increased microbial population growth in rams fed at a 2% concentrate level, which in turn improved digestion and increased the amount of nutrients available to stimulate sheep weight gain. When the concentrate was administered at 2% of body weight, higher concentrate level supplementation encouraged greater roughage intake, total feed intake, and nutrient digestion and utilization. This is consistent with the findings of Ayele *et al*. (2017), who fed hay supplemented with concentrate to Ethiopian fat tail hair sheep at varying levels; the sheep on higher levels exhibited improved feed intake and utilization. Dereje *et al.* (2016) found increased consumption in goats fed concentrate at 1.5% of body weight compared to those fed at 1%, which is consistent with the current study.

The current study's observation of the interaction between breed and concentrate level reveals that the three breeds' performance was superior when fed concentrate at a rate of 2% of body weight as opposed to when raised on a rate of 1% of body weight. Compared to the other two breeds, Balami had a higher intake, which could be related to its higher feed need. In comparison to earlier studies (Kasahun, 2000; Wogenie, 2007; Hailu *et al,* 2011; Likawent *et al.*, 2012; Firisa *et al.*, 2013) where sheep were fed a basal diet of hay supplemented with

various types of concentrate, the range of values in ADG observed for the three breeds supplemented with concentrate at 2% of body weight was higher. On the other hand, their average daily weight gains were in line with the same range found by the same authors when they were fed concentrate at 1% of body weight. The results of this investigation were similarly consistent with those published by Tsegay *et al.* (2013), who noted that sheep supplemented with 350 g/d of concentrate had more ADG than those supplemented with 150 g/d. According to Dereje *et al*. (2016), goats supplemented with 1.5% of their body weight in concentrate had higher ADG than goats fed 1% of their body weight in concentrate. This clarifies further why larger weight gains were noted in rams fed concentrate at 2 percent of their body weight in all the breeds in this study as opposed to their corresponding counterparts fed 1 percent of their body weight. These rams not only maintained their weight but also increased their growth.

This provides more evidence for the need that animals, especially ruminants, be provided diets that contain all the nutrients they need in addition to enough of those diets to meet production needs.

Conclusion

The study demonstrated that the rams' performance was impacted by their concentration level. The average daily weight gain (ADG) and feed intake demonstrated the disparities in nutritional quality; for example, concentrate supplied at 1% of body weight produced an ADG of 150% and a higher feed intake than concentrate fed at 2% of body weight. The study also showed that compared to Uda and Yankasa, Balami had the best feed intake and ADG (6.67% and 45.45%, respectively).

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Table 1: Chemical composition (%) of *D. smutsii* hay, maize (38%), maize offal (18.9%), and cottonseed
cake (39.1%), mineral mixture (2.50%), common salt (1.50%), and experimental concentrate

Nutrients (%)	Ingredients				Concentrate
	D. Smutsii	Maize	Maize offal	Cotton seedcake	
Dry Matter	91.63	91.18	91.15	91.23	92.78
Organic Matter	83.90	86.76	81.87	89.01	81.23
Crude Protein	5.76	8.31	11.69	28.58	13.63
Ether Extract	4.05	8.03	11.03	11.05	17.15
Crude Fibre	62 .89	45.21	53.92	50.21	27.40
ADF	43.12	43.27	34.99	42.35	45.95
NDF	42.21	48.01	45.21	47.23	56.27
Nitrogen free extract	15.01	18.61	14.46	6.31	22.00
Ash	8.92	11.02	10.05	4.98	11.55
ME (MJ/kg DM)	9.81	10.69	10.88	10.51	11.40
Cost ($ per kg)	0.07	0.15	0..06	0.07	0.37

The ME values of the experimental feed ingredients were calculated as per Maff (1975) as follows: ME= (MJ/kg DM) = 0.012CP + 0.031EE + 0.005CF + 0.014NFE.
ME =Metabolisable Energy, MJ/KJDM = Mega Joule per kilo joules dry matter

Table 2: Effect of breed on feed intake and body weight change of Balami, Uda and Yankasa rams fed *D. smutsii* hay supplemented with concentrate at different levels

	Breed			SEM	LOS
Parameter	Balami	Uda	Yankasa		
Daily Con. Intake (Kg DM)	0.66[a]	0.65[a]	0.59[b]	0.03	*
Daily Hay Intake (Kg DM)	0.66[a]	0.69[a]	0.59[b]	0.03	*
ADFI (Kg DM)	1.32[a]	1.34[a]	1.28[b]	0.03	*
Intake/Metabolic Weight ($W^{0.75}$)	0.10	0.10	0.09	0.06	NS
Initial Weight (Kg)	34.20[a]	35.35[a]	31.80[b]	0.93	*
Metabolic Weight ($W^{0.75}$)	14.14	14.49	13.39	0.82	NS
Final Weight (Kg)	48.90[a]	48.60[a]	42.03[b]	1.27	*
Average Weight Gain (Kg)	14.70[a]	13.25[a]	10.23[b]	0.52	*
Average Daily Weight Gain (Kg)	0.16[a]	0.15[a]	0.11[b]	0.01	*
Feed / Gain	8.73[a]	9.82[a]	11.32[b]	0.67	*

[a, b] Means bearing different superscripts within the same row differ significantly (P<0.05), Standard error of means (SEM), Kilogramme (Kg), Dry matter (DM), litre (l), Average daily feed intake (ADFI), Significant at 5% (*), Not significant (NS)

Table 3: Effect of concentrate level on feed intake and body weight change of Balami, Uda and Yankasa rams fed D smutsii hay supplemented with concentrate at different levels

	Concentrate level		SEM	LOS
Parameter	*1 %*	*2 %*		
Daily Con. Intake (DM Kg)	0.40[b]	0.87[a]	0.02	*
Daily Hay Intake (DM Kg)	0.61[b]	0.69[a]	0.03	*
Average Daily Feed Intake (Kg)	1.17[b]	1.59[a]	0.05	*
Intake/Metabolic Weight ($W^{0.75}$)	0.08	0.11	0.03	NS
Initial Weight (Kg)	34.70[b]	32.87[a]	0.91	*
Metabolic Weight ($WKg^{0.75}$)	14.30	13.72	0.79	NS
Final Weight (Kg)	42.10[b]	50.92[a]	1.03	*
Weight Gain (Kg)	7.40[b]	18.05[a]	0.42	*
Average Daily Gain (Kg)	0.08[b]	0.20[a]	0.01	*
Feed / Gain	14.63[b]	7.95[a]	0.55	*

[a, b] Means bearing different superscripts within the same row differ significantly (P<0.05), Standard error of means (SEM), Kilogramme (Kg), Dry matter (DM), litre (l), Average daily feed intake (ADFI), Significant at 5% (*), Not significant (NS)

Table 4: Interaction effect of breed and concentrate level on feed intake and body weight change of Balami, Uda and Yankasa rams fed *D. smutsii* hay supplemented with concentrate at different levels

	Concentrate level						SEM	LOS		
	1 %			*2 %*				B	C	BxC
	Breed									
Parameter	*Balami*	*Uda*	*Yankasa*	*Balami*	*Uda*	*Yankasa*				
Daily Con. Intake (DM Kg)	0.41	0.41	0.37	0.91	0.89	0.82	0.04	*	*	*
Daily Hay Intake (DM Kg)	0.65	0.65	0.54	0.67	0.74	0.66	0.04	*	*	*
Average Daily Feed Intake (Kg)	1.17	1.23	1.11	1.68	1.66	1.45	0.08	*	*	*
Intake/Metabolic Weight (W Kg $^{0.75}$)	0.08	0.08	0.08	0.12	0.12	0.11	0.04	NS	NS	NS
Initial weight (Kg)	35.8	36.50	31.80	32.60	35.20	31.80	1.32	*	*	*
Metabolic Weight (W Kg $^{0.75}$)	14.64	14.85	13.39	13.64	14.14	13.39	1.04	NS	NS	NS
Final Weight (Kg)	43.80	43.50	39.0	53.70	52.00	45.06	1.79	*	*	*
Weight Gain (Kg)	7.70	7.30	7.20	21.10	16.80	13.26	0.73	*	*	*
Average Daily Weight Gain (Kg)	0.09	0.08	0.08	0.23	0.18	0.15	0.01	*	*	*
Feed / Gain	13.00	15.38	13.87	7.30	9.22	9.67	0.94	*	*	*

Standard error of means (SEM), Kilogramme (Kg), Dry matter (DM), litre (l), Level of significance (LOS), Not Significant (NS), Significant at 5 % (*), Breed (B), Concentrate (Con.), Breed x Concentrate (BxC), Significant at 5% (*), Not significant (NS)