

QUANTITATIVE AND QUALITATIVE BUFFALO (*Bubalus bubalis* L.) CARCASS CHARACTERISTICS FED WITH A DIFFERENT RELATIONSHIP OF ROUGHAGE AND CONCENTRATE ON A FEEDLOT SYSTEM IN BRAZIL

Características Quantitativas e Qualitativas de Carcaças de Búfalos (Bubalus bubalis L.) Alimentados com Diferentes Proporções de Volumoso e Concentrado em Regime de Confinamento no Brasil

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Abstract

Eighteen non castrated Murrah male buffaloes, averaging 403 kg in weight, have been used in a feed lot randomized complete-block design, to test three different diets (T) with different combination of roughage (R) and concentrate (C). Tukey test has been used (5% of significance) to evaluate the obtained averages. The trial was carried on at AGRONOMIC INSTITUTE OF PARANÁ (Pinhais town, Paraná, Brazil), during 91 days. The animals have been fed twice daily, and the diets contained (%): T₁=75 R : 25 C; T₂=65 R : 35 C and T₃=55 R : 45 C, and it was calculated to have the same level of protein and energy in its composition, aiming to evaluate the diets effects on the animals' performance on body weight and carcass characteristics. The R utilised was corn silage plus 0.5% of urea. The C was composed by soybean, wheat meal, corn, cottonseed, plus mineral, presenting: T₁=32.78 and 71.08; T₂=24.17 and 66.50; T₃=20.23 and 63.84, in percentage of crude protein and total digestive nutrients, respectively. The following quantitative characteristics have been evaluated: Hot Carcass Weight (HCW); Cold Carcass Weight (CCW); Hot Carcass Dressing Percentage (HCP); Cold Carcass Dressing Percentage (CCP); Loss After Cooling (LC); Carcass Length (CL); Leg Length (LL); Thigh Thickness (TT); *Longissimus dorsi* muscle area between 12th and 13th ribs (LA); Loin Area per 100kg of Cold Carcass (LA/100kg CC); Loin Fat Thickness Under the Skin, measured between the 12th and 13th ribs (LF); Bones Percentage (BP), Muscle (MP) and Fat (FP) of the Carcass - data, relative to 9th, 10th and 11th ribs. The evaluated qualitative characteristics were: Carcass Conformation (CONF); Meat Marbling (MM); Meat Texture (MT); Meat Color (MC). The diets have not affected (P > 0.05) the main carcass characteristics: HCW(kg)=265.83; 267.67 and 268.67; CCW(kg)=257.97; 260.92 and 259.27; HCP(%)=50.28; 51.20 and 51.05; CCP(%)=48.80; 48.81 and 49.45; LC(%)=2.96; 2.91 and 3.13; CL(cm)=133.75; 133.50 and 135.83; LL(cm)=70.66; 71.33 and 72.40; TT(cm)=26.16; 26.25 and 26.25; LA(cm²)=65.48; 67.83 and 62.76; LA/100kg CC(cm²)=25.37; 26.16 and 24.20; LF(mm)=7.58; 8.42 and 6.88, respectively for T₁, T₂, and T₃. Higher values (P < 0.05) of BP (%) have been observed in T₃ (17.32) when compared with T₁ (16.06). However, T₂ (16.38) had a non-significant difference (P > 0.05). The MP (%) and FP (%) were similar (P > 0.05) for the three diets, and the values were: T₁=56.47 and 27.85; T₂=61.07 and 22.73; T₃=59.00 and 23.50, respectively. The diets have not affected (P > 0.05) the qualitative carcass characteristics, and the marbling observed has been classified as soft. It has been concluded that the use of different relations of roughage and concentrate for non-castrated male buffaloes, submitted to a confined system, on diets of the same protein and energy levels, at the trial conditions, have not influenced the productive performance of the animals, neither the carcass qualitative and quantitative characteristics.

Keywords: Buffalo meat; Murrah; Buffalo feedlot; Buffalo nutrition.

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Resumo

Dezoito búfalos Murrah, machos, não castrados, com peso médio de 403 kg, foram utilizados num experimento de confinamento em blocos completamente casualizados, para testar diferentes dietas (T) com diferentes proporções de volumoso (R) e concentrado (C). As médias obtidas foram comparadas pelo teste de Tuckey (5% de significância). O experimento foi conduzido no Instituto Agronômico do Paraná (Município de Pinhais, Paraná, Brasil), durante 91 dias. Os animais foram alimentados duas vezes ao dia e as dietas continham (%): $T_1=75 R : 25 C$; $T_2=65 R : 35 C$ e $T_3=55 R : 45 C$, tendo sido calculadas para o mesmo nível de proteína e energia, objetivando avaliar o efeito das dietas no desempenho, no peso corporal e nas características de carcaça dos animais. O volumoso (R) utilizado foi a silagem de milho com 0,5% de uréia. O concentrado (C) era composto de farelo de soja e trigo, milho, semente de algodão, mais minerais, apresentando: $T_1=32,78$ e $71,08$; $T_2=24,17$ e $66,50$; $T_3=20,23$ e $63,84$, por cento de proteína bruta e nutrientes digestíveis total, respectivamente. Foram avaliadas as seguintes características das carcaças: Peso da Carcaça Quente (HCW); Peso da Carcaça Fria (CCW); Rendimento de Carcaça Quente (HCP); Rendimento de Carcaça Fria (CCP); Perdas no Resfriamento (LC); Comprimento da Carcaça (CL); Comprimento da Perna (LL); Espessura do Coxão (TT); Área do músculo *Longissimus dorsi*, entre a 12ª e a 13ª costelas (LA); Área do lombo por 100 kg de carcaça fria (LA/100kg CC); Espessura de gordura de cobertura, medida entre a 12ª e a 13ª costelas (LF); Porcentagem de Ossos (BP), Músculos (MP) e Gordura (FP) da carcaça – dados relativos à 9ª, 10ª e 11ª costelas. As características qualitativas avaliadas foram: Conformação da Carcaça (CONF); Marmoreio da Carne (MM); Textura da Carne (MT); Cor da Carne (MC). As dietas não afetaram ($P > 0,05$) as seguintes características de carcaça: HCW (kg) = 265,83; 267,67 e 268,67; CCW (kg) = 257,97; 260,92 e 259,27; HCP (%) = 50,28; 51,20 e 51,05; CCP (%) = 48,80; 48,81 e 49,45; LC (%) = 2,96; 2,91 e 3,13; CL (cm) = 133,75; 133,50 e 135,83; LL (cm) = 70,66; 71,33 e 72,40; TT (cm) = 26,16; 26,25 e 26,25; LA (cm²) = 65,48; 67,83 e 62,76; LA/100kg CC (cm²) = 25,37; 26,16 e 24,20; LF (mm) = 7,58; 8,42 e 6,88, respectivamente para T_1 , T_2 e T_3 . Maiores valores ($P < 0,05$) de BP (%) foram observados no T_3 (17,32) quando comparado com T_1 (16,06). Contudo, T_2 (16,38) não apresentou diferença significativa ($P > 0,05$). A MP (%) e FP (%) foram similares ($P > 0,05$) para as três dietas, cujos valores foram: $T_1=56,47$ e $27,85$; $T_2=61,07$ e $22,73$; $T_3=59,00$ e $23,50$, respectivamente. As dietas não afetaram ($P > 0,05$) as características qualitativas das carcaças, e o marmoreio observado foi classificado como suave. Pode-se concluir que o uso das diferentes relações de volumoso e concentrado propostas, para búfalos inteiros submetidos ao regime de confinamento, com dietas isoprotéicas e isocalóricas, não influenciou o desempenho reprodutivo dos animais, tampouco as características qualitativas e quantitativas das carcaças.

Palavras-chave: Carne de búfalo; Murrah; Confinamento de búfalos; Nutrição de búfalos.

Introduction

The worldwide buffalo herd is represented by approximately 1/9 of the number of the bovine heads (SHALASH, 1991; COCKRILL, 1994).

According to Chopra (1991), there are 137 million buffalo heads on the Planet in 1991, and 96.5% of them are located at the Asiatic Continent. The concentration of the buffalo herd is verified between the Equator Line and the Parallel 30°N, at the Asiatic Continent, at regions of the planet where major climatic adversities and the worst economical and social problems can be found (SHALASH, 1994).

Cockrill (1994), reports that: the buffalo population growth rate is expressive worldwide. However, it is at the Americas that a faster evolution has been recognized, and a considerable expansion of the production is predictable.

According to Fao (2002), there are 165 million of buffalo heads worldwide.

The buffalo production appears as an excellent alternative, regarding to make the most of the Brazilian pastures system (extensive, with seasonal production), and also about the meat production in an intensive system (confined or semi-confined), through the adequate use of roughage and concentrate feed.

Since the introduction of buffaloes in Brazil, in 1890, the national herd growth has, by itself, justified the experimental action on developing programs (SANTOJANI, 1913; BRASIL, 1958; EMBRAPA - CPATU, 1986). The most recent count reports a total of 2.5 million animals (ASSOCIAÇÃO BRASILEIRA DE CRIADORES DE BÚFALOS, 1996).

The national bovine herd average performance indexes are, in many regions, lower than those verified in some Latin American countries. So, studies to improve the productive systems, as well as the meat production alternatives, on a rational and economical way, must be intensified. Also, due to the fast and recent changes on the world economical systems, and according to the market globalization, alternatives for the underdevelopment countries must be searched, looking for comparative advantages.

In Brazil, the buffalo meat production has a promising market (almost incomparable in Latin America) due to the characteristics presented by the species (rusticity, adaptability, fertility and docility) and also because of the soil and climatic conditions of the country.

The objective of this work was the study of confined buffalo (*Bubalus bubalis L.*) carcass characteristics. The animals have been submitted to three relations of roughage and concentrate feed, aiming to offer information to farmers working on intensive meat production. From the collected data, a reference of the animal performance on the proposed conditions shall be achieved. Then, according to each situation, technicians and farmers, interested on buffalo breeding, may elaborate their own feed handling systems, allowing them to maximize their available resources.

Literature review

Cattle breeding in Brazil should be looked as one of the most efficient factors for the social-economical development of the country-side. Besides the generation of constant money income for the producers, the cattle raising activity may also: be a source of complementary food for the family; make the most of the exceeds and the agriculture residues, turning them into high biological value proteins; use the familiar workmanship effectively in small properties, and benefit the integrated exploration on the various productive systems.

Acharya (1988) reports that at the Southeast Asia, where the buffalo rules, most of the properties are small ones (around 1.0 ha), and the buffalo breeding is complementary to the grain production and uses simple techniques. The animals are used to: work, manure production, and make the most from the sub-products of the plan-

tation. At South Asia, small producers raise 99% of the buffaloes, and the animals are kept in the "small yards system" for milk, meat and work. Its feeding is based on agricultural residues, such as: wheat and rice straw, supplemented by pasture and concentrates (RANJHAN, 1992).

Buffalo breeding is promising in regions where the use of technologies is low. Padda (1984), for example, reports that the buffalo production in India features the following advantages: the animals do not compete with humans for high value food (they use wheat and rice straw, corn plants, and sugar cane tips); the confined systems are economically viable; they are resistant and docile.

Buffaloes, on a confined system, have shown a satisfactory result using feed of high and low quality, as long as they are used adequately. Silva; Martinez e Alvarez (1996), studying confined buffalo performance, on a roughage diet, based on sugar cane (*Sacharum officinarum*), have obtained a average weight gain of 0.843kg/day, the animals were precociously slaughtered, at the age of 18.9 months. Briquet Júnior (1967) reports that the most important aspects of a commercial carcass are: a) fat distribution; b) rate (%) of bones, meat and fat; c) meat quality: color, firmness (texture), and palatability (through the tenderness, the flavor, and the marbling fat).

According to Salomoni (1981), some factors may have an influence on the meat quality: a) endogenous (from the animal itself), such as: breed, sex and age; b) exogenous (those that have a straight relation with the individual) such as: diet, climatic conditions, topography, and the altitude where the animals are raised, and as well as: the influences of the handling before the slaughtering, and the slaughtering system itself. The results of the isolated or combined influences of those factors will lead to alterations on the qualitative and quantitative carcass characteristics. In spite of many studies about buffalo meat production and carcass characteristics, the literature data have a lack of precise information about the animal's description, what may difficult the adequate comparison of the results obtained by many authors (JOSHI, 1988). Besides that, most of the works about carcass evaluation have no concrete information about the referential weight, used for the calculation of the carcass performance (weight at the farm - on fastening - weight at the Slaughtering-House, or empty weight). Moletta (1990) reports that there are many

research works on this field, so, there is a margin for errors on the comparisons, due to the extraction of the renal fat from the processed carcasses by the Slaughtering-Houses in Brazil, what, frequently, do not occur in other conditions. Many articles about buffaloes do not clarify if the carcass performance has been obtained with hot carcass (HCP), or with cool carcass (CCP). The results are also different due to the type (swamp or river), sex, breed, age, methodologies adopted by the different authors for the cut of the carcass, and the weight at slaughtering.

On a study of the influence of different nutrition levels over the carcass of male buffaloes, Pathak; Baruah e Ranjhan (1983) had not verified significant alterations. Although Pathak; Ranjhan e Baruah (1987) reported that there has been an effect of the higher levels of protein and energy over the buffalo carcass dressing percentage (CDP), in which has had a variation from 50.1% to 51.8%, as well as over the animal growth response.

Margon, et al (1983), have verified that for confined buffaloes, the medium CDP has had a variation from 43.64% to 46.67%. Naidu; Raghavan; Damodar (1984), have observed that there has been a raise over the carcass weight, in which the levels of concentrate feed on the diet various from 15% to 20%. Thair, et al (1985) have reported a variable CDP according to the age of the animals: 51.8% (21 months) and 50.5% (26 months). Lorenzoni, et al (1986), comparing different genetic groups, have verified an average CDP of 50.32% for buffaloes. Reddy; Jatkar e Damodar (1990), testing the effects of diets with different proportions of roughage and concentrate feed, have verified that the animals that received the concentrate feed, have shown a higher CDP. Moletta (1990) have verified a HCP of 48.59% and CCP of 47.94%, for buffaloes of the Mediterranean breed, which results were similar to those obtained for the breeds Aberdeen Angus (51.00% and 50.29%) and Charoles (51.00% and 50.05%), being, however, lower than Nelore breed (54.56% e 53.81%). Moletta et al, (1993) have evaluated the carcass characteristics of the breeds Mediterranean (ME) and Murrah (MU), raised under pasture conditions and slaughtered at 27 months, not checking differences between the breeds, which HCP (over the average slaughtering weight = 433.8kg) were: ME = 49.64% e MU = 50.52%. Moletta; Silva e Martinez (1993), evaluating the carcass characteristics of

buffaloes raised on pastures of *Brachiaria humidicola* (humidicola) or *Hemartbria altissima* (hemartbria), have obtained respectively 51.22% and 48.83% of HCP ($P < 0.05$), for both studied grasses.

Gazzetta, et al (1995) affirm that the buffaloes present lower body composition than the Nelore breed. The buffaloes have presented, also, higher values to: bone weight, fat filings, head, leather, feet knuckles, stomach, empty intestines and fat thickness over the loin. For HCP and CCP, based at the slaughtering weight, the values were: ME=52.64% e 51.44%; JA=52.55% e 51.45% e NE=58.27% e 57.18%, respectively.

According to Sekhon, et al (1996), in a feed lot study using males of the Murrah breed, it has been observed a higher CDP, with a raising of the nutritional level of the used diet (100, 115 and 130% of the NRC), as well as with the stage of maturation on which the animals have been slaughtered (8, 12 and 18 months).

According to Charles; Johnson (1975), the average muscle percentage - MP (65.5%), bones - BP (15.9%) and fat - FP (16.0%) from the swamp buffalo carcass, aging between 11 to 20 months, have not been influenced by the alimentary system. Johnson; Charles (1975) have verified that the buffaloes showed 36.4% of MP, 10.7% of FP (in relation to the live weight acquired in 131 days confined = 87 Kg), when comparing the swamp buffalo carcass characteristics to the bovines Angus, Hereford and Frisian. These values were considered better than Hereford values (MP=22.2% and FP=44.5%); Frisian (MP=30.4% and FP=17.9%) and Angus (MP=12.8% and FP=59.0%). On the other hand, the buffaloes have shown a higher proportion of carcass connective tissue (2.6%), than the bovines Angus (1.9%) and Hereford (1.9%).

Naidu; Raghavan e Damodar (1984) have not checked an effect of the relation roughage and concentrate (85:15 or 80:20) on the male Murrah diet, over the slim meat proportion, BP, FP and over the weight of the prime organs.

The carcass characteristics of different age buffaloes have been estimated by Thair et al, (1985), and the following results have been obtained: 59.2% and 59.5% (MP); 8.5% and 11.6% (FP); 32.4% and 28.9% (BP), respectively, for the ages 21 and 26 months at slaughtering. The authors have concluded that, the higher the age on which buffaloes were slaughtered, the bigger the proportion of FP and smaller the BP on the carcass.

Comparing the performance and the carcass characteristics of confined and slaughtered buffaloes and bovines at the age of 24 months, Moletta (1990) reports that the buffaloes have shown 57.91%, 25.73% and 16.34%, for MP, BP and FP, respectively. The percentage estimates of BP, MP and FP, were obtained according to Hankins e Howe (1946)⁵, for bovines. In this way, the data may not be precise for buffaloes, and there is the need to develop studies to check that, for this species, the equations obtained by the authors are adequate.

While estimating the carcass characteristics of buffaloes raised on pastures of humidicola or hemartria, Moletta; Silva e Martinez (1993) have not verified the influence of the grass over the relation MP : OS : FP, which the obtained values have been: MP=64.14% and 63.25%; OS=16.70% and 16.06% e FP=19.15% and 20.97%, respectively.

According to Sekhon, et al (1995), on a study carried with Murrah breed males, there is an influence of the nutritional level (100, 115 e 130% of the recommended), over the protein, FP and meat total pigments, that were higher with the raise of the nutritional level.

According to Moletta (1990), the loss after cooling (LC) is the percentage of weight loss of the hot carcass in relation to the cold carcass, after 24 hours of cooling at 1°C of temperature. Lorenzoni, et al (1986) have not checked a significant difference for the LC between the carcasses of bovine Nelore (1.65%), Frisian (1.35%) and buffaloes (2.10%). Comparing the LC of the carcasses of bovine Charoles (1.83%), Aberdeen Angus (1.40%) and Nelore (1.34%), to buffaloes (1.33%), Moletta (1990), have not checked any difference between the two genetic groups. Müller, et al (1994b) have obtained higher values for LC for buffaloes of the Mediterranean breed (2.15%), when compared to the bovine Charoles (1.49%).

Based on the data presented by Gazzetta, et al (1995), for the weight of hot and cold carcass, during a study that has compared the carcasses of bovine Nelore (NE) and buffaloes Mediterranean (ME) and Jafarabadi (JA), it was possible to calculate the LC. It has been verified that: NE=1.90%; ME=2.29% and JA=2.06%.

Carcasses of Mediterranean and Murrah breeds were evaluated by Lourenço Júnior, et al

(1980), showing respectively 119.5 cm and 117.2 cm, for the carcass length (CL). Moletta (1990), on a study of the characteristics of bovine animals Charoles (CH), Aberdeen Angus (AN), Nelore (NE) and buffaloes (BU), have verified that the CH have presented a higher CL (124.6 cm), compared to the AN (118.90 cm), NE (119.22 cm) e BU (119.63 cm). For the thigh thickness (TT), there have been no difference between the two genetic groups, the values were: CH=25.68 cm; AN=23.83 cm; NE=24.93 cm e BU=26.35 cm. The data related to the leg length (LL) have indicated a similarity between the animals NE e BU, BU and CH and also between CH and AN, which obtained values were: CH=65.58 cm; AN=61.03 cm; NE=70.98 cm e BU=67.36 cm. Moletta; Silva e Martinez (1993), on a study about the carcass characteristics of Mediterranean and Murrah buffalo breeds, fattened on pastures, have verified for the two breeds respectively, the following values: CL=126.39 cm e 127.53 cm; LL=70.71 cm e 70.64 cm; TT=25.62 cm and 25.58 cm. There is no statistical difference between the two breeds.

Müller, et al (1994a), evaluating Mediterranean buffaloes carcasses, raised on pastures, on three different systems (A, B and C), have not verified an influence of the raising system over the CL (A=123.68 cm; B=122.92 cm e C=122.00 cm), LL (A=69.81 cm; B=70.31 cm e C=70.31 cm), or over the TT (A=23.75 cm; B=23.1 cm e C=22.91 cm). Comparing the carcass characteristics of bovine Charoles (CH) and Mediterranean buffaloes, slaughtered with 434 kg and 435 kg of live weight, respectively, Müller, et al (1994b) have verified for BU, higher LL (69.81cm), than for CH (67.36cm). For CL and for TT, there has not been a difference between the two genetic groups, which values were equal to: CH=122.86 cm e 22.86 cm e BU=123.68 cm e 23.75 cm. Gazzetta, et al (1995) have verified that for Nelore bovines a higher CC (126.09 cm) than for Jafarabadi (123.68 cm) and Mediterranean (122.51 cm) buffaloes.

The determination of the loin area (LA) is made through a transversal cut of the carcass, between the 12th and 13th ribs, calculating the *Longissimus dorsi* muscle perimeter (MÜLLER, 1987). The LA is a high heritage characteristic (h²), and for meat cattle, it is estimated at 0.69, showing a high correlation with total carcass performance (BRIQUET JÚNIOR, 1967). However, the same author

⁵ The HANKINS e HOWE method (1946) has also been used to estimate the muscles, bones and fat of the experimental animals carcasses, having, as such, the same error margins.

affirms that the determination of the genetic correlation is subjected to a major variation during the sampling, so, the results may differ among the authors on the same study area.

Cross, et al (1973), quoted by Moletta (1990), have reported that the LA has a correlation of 0.77 with the weight of commercial cuts and of 0.30 with the percentage of these cuts, and, as well, it also presents a negative correlation of -0.28 with the percentage of the carcass bones. However, Jorge, et al (1993b) sustain that the LA has not shown a reliable indicator of muscles, having presented a non-significant correlation of 0.11 with the amount of muscles on the carcass. The authors have found a significant correlation of the LA with the amount of bones (-0.26) and with the relation muscles: bones (0.33).

Lorenzoni, et al (1986) studies on bovines Nelore (NE), Frisian (HO) and buffaloes (BU), have revealed LA of 59.9 cm², 56.7 cm² and 55.3 cm², respectively. The values of LA regarding the hot carcass weight (LA/100 kg of carcass), were: NE=25.59 cm²; HO=25.93 cm² e BU=25.19 cm². On a carcass evaluation study of the of buffaloes raised on *Hemarthria altissima* (HE) or *Brachiaria humidicola* (HU) pastures, Moletta; Silva; Martinez (1993) have not verified an statistical difference for LA of the animals, on both grasses, which values were: HE=59.69 cm² or 28.61 cm²/100 kg of carcass and HU=64.63 cm² or 29.53 cm²/100 kg of carcass. According to the data obtained by Moletta, et al (1993) for the carcass characteristics of buffaloes Murrah (MU) and Mediterranean (ME), raised on pastures, there is no statistical difference between the breeds, for LA, which values were: MU=61.11 cm² or 27.84 cm²/100 kg of carcass and ME=65.39 cm² or 30.34 cm²/100kg of carcass. Gazzetta, et al (1995) report the superiority of bovines Nelore-NE (62.34 cm²) over the buffaloes Jafarabadi-JA (57.27 cm²) and Mediterranean-ME (56.92 cm²), for LA. The calculated values for LA/100 kg of hot carcass, based on the data presented on the work were: NE=22.74 cm²; JA=23.57 cm² and ME=23.43 cm².

Lourenço Júnior, et al (1980) have obtained for LF on the breeds Murrah and Mediterranean equal to: 4.9 mm and 5.3 mm, respectively. Lorenzoni, et al (1986) had not verified a statistical difference for loin fat thickness (LF) of the buffalo carcass (9.4 mm), Nelore (7.8 mm) and Frisian (5.8 mm). Moletta (1990) has obtained values for LF on

bovines Charoles-CH (1.16 mm), Angus-AN (3.48 mm), Nelore-NE (4.33 mm) and buffaloes-BU (3.08 mm), and has verified a difference between the two genetic groups, having the animals AN and NE, presented the higher LF values. For LF on the carcass of buffaloes raised on brachiaria (BH) e hemartria (HA) pastures, Moletta; Silva e Martinez (1993) have not verified an influence of the grass, having obtained for BH 4.68 mm and for HA 3.95 mm. Moletta, et al (1993), comparing the carcasses of buffaloes raised on pastures, have not found differences between the breeds Murrah (4.83 mm) and Mediterranean (3.75 mm) for LF.

Carcasses of buffaloes submitted to three systems of pastures were evaluated by Müller, et al (1994a). They have obtained LF values significantly higher than for those animals raised on cultivated pastures (5.32 mm) and native pastures (4.13 mm), in relation to those kept on cultivated pastures for two hours a day, plus native pastures (2.43 mm). Comparing the carcass characteristics of bovines Charoles and buffaloes, Müller, et al (1994b) have obtained a similar LF, which values were equal to 3.36 mm e 5.32 mm, respectively. According to Gazzetta, et al (1995), animals of the Nelore breed have presented a lower LF on the carcass (5.03 mm), than the buffaloes Jafarabadi (9.93mm) and Mediterranean (11.10 mm). Also, between the buffaloes there has been a higher LF value for the Mediterranean breed.

According to Matsukawa; Tilakaratne e Buvanendran (1976a), when slaughtered young, the buffaloes present a meat quality comparable to bovines. Thair, et al (1985) have reported that buffaloes present a superior ability to convert low quality feed into meat.

Anjaneyulu, et al (1985), evaluating the raising levels of digestible proteins (60, 80, e 100% of the recommended), over some carcass characteristics, verified that the animals that have received diets with 80% of digestible proteins presented leaner meat than those that received 100%. Dahlan; Abu Hassan e Sukri (1988), on a study of evaluation of the meat quality of swamp buffaloes, have noticed that an increase at the marbling rate provides higher meat softness. They have also concluded that the meat of the confined animals has presented a higher softness and a lighter coloration, than those rose over pastures.

Comparing the carcass characteristics of different genetic groups, Moletta (1990) have ob-

tained for buffaloes lower qualitative values than for bovines, regarding the marbling (2.00) and coloration (2.33), have not checking, although, a difference regarding conformation (good -) between buffalo and Nelore, as well for the texture (3.00), this last one being classified as lightly crude for all the bovines studied.

Jorge, et al (1993a), on a work that have evaluated the carcass physical composition of different genetic groups of non-castrated animals (Nelore-NE, Bi-crossbred-BC, F₁ Frisian x Nelore-FN and crossbred Mediterranean buffaloes-BU), have verified that the buffaloes have presented a higher tendency to accumulate fat tissue, having obtained the following values for this characteristic: 24.4% (NE); 21.6% (BC); 19.5% (FN) e 27.6% (BU), respectively.

Müller, et al (1994a) have evaluated the carcass characteristics of Mediterranean buffaloes on pasture system (T1-cultivated pasture; T2- 2h/day on cultivated pasture, and the rest of the day on native pastures; T3-native pasture) for 112 days, with the slaughtering weight fixed at 450 kg. The authors have verified that the treatments had no influence over the estimated qualitative parameters, except for the marbling and conformation, which obtained values were: marbling (MAR) = 3.12; 1.37 and 2.00; conformation (CONF) = 9.0; 8.5 and 8.5; color (COL) = 3.0; 3.62 and 3.37; texture (TEX) = 2.62; 2.00 and 2.37, for the three treatments (T1, T2, T3) respectively. Based on this data, it has been concluded that the buffaloes have produced meat of acceptable quality. Müller, et al (1994b), comparing the carcasses of bovines Charoles (CH) and buffaloes Mediterranean (BU), have observed the following values for some qualitative characteristics, for CH and BU, respectively: CONF=11.36 e 9.0; COL=5.0 e 3.0; TEX=4.45 e 2.62; MAR=5.27 e 3.12. Despite they have shown inferior qualitative characteristics, the authors affirm that the buffaloes have produced carcasses with an acceptable quality.

Material and methods

The study has been conducted at the Agronomic Institute Experimental Station, Parana, Brazil (25° 25'S - latitude; 49° 08'W - longitude and 930 meters of altitude), which predominant climate is type Cfb (according to KÖEPPEN classificati-

on), during 91 days. Eighteen males, non-castrated Murrah buffaloes (*Bubalus bubalis L.*) were used. The initial average live weight was 403 kg (after 14 hours of solid fastening). The buffaloes were confined on batches of three (10.90 m² per animal), at non covered installations. The slaughtering has been done after 17 hours of complete fastening. The carcass characteristics (quantitative and qualitative) were evaluated according to the diet offer, containing 3 (three) relations of roughage (V) and concentrate (C), on three treatments (T₁=75% V: 25% C; T₂=65% V: 35% C and T₃=55% V: 45% C). The roughage was corn silage. On each treatment, it has been used a concentrate in order to obtain the same level of protein (1.200 g of CP/head/day) and energy (70% of Total Digestible Nutrients - TDN). The feed TDN values were calculated, according to the equations proposed by the LATIN AMERICAN TABLES OF FEED COMPOSITION (1974), for bovines, based on the results of the chemical analysis. The diet has been supplied to the animals twice a day (8:30 AM and 3:30 PM) half of the daily supply was offered (roughage + concentrate) at each time. The weighting was carried out as follows: a) at the beginning of the trial (solid fastening for 14 hours); b) every 28 days, being offered only 70% of the food volume, always in the morning period of the day before the weighting. The animals have been slaughtered, eviscerated and the carcasses have been processed according to the routine established at the Slaughtering-House. The half of the carcasses of each animal was identified, weighted, and cooled to the inside temperature of 1°C for 24 hours. For the evaluation, it has been used the left side of the carcasses, after cooling, following the methodology proposed by Müller (1987). The following quantitative characteristics have been evaluated: Hot Carcass Weight (HCW); Cold Carcass Weight (CCW); Loss After Cooling (LC); Hot Carcass Percentage (HCP); Cold Carcass Percentage (CCP); Carcass Length (CL); Leg Length (LL); Thigh Thickness (TT); *Longissimus dorsi* muscle area between 12th and 13th ribs (LA); Loin Area per 100kg of Cold Carcass (LCC); Loin Fat Thickness Under the Skin, measured between the 12th and 13th ribs (LF); Bones Percentage (BP), Muscle (MP) and Fat (FP) of the Carcass data, relative to 9th, 10th and 11th ribs (MÜLLER et al., 1973). The evaluated qualitative characteristics were: Carcass Conformation (CONF); Meat Marbling (MM); Meat Texture (MT); Meat Color

(MC). The live weight has been obtained at the moment of the animals' departure to the Slaughtering-House, after a solid fastening of 16 hours. An outlining of randomized complete-block design has been used (GOMES, 1987). It was composed of three treatments and six animals per treatment, and the animals in each treatment were blocked by the initial living weight (heavier and lighter). The *Statgraphics* program has been used to the statistical analysis. Tukey Test, on 5% significance level, was used to compare the averages.

Results and discussion

The observed average values for hot carcass weight (HCW), cold carcass weight (CCW), loss after cooling percentage (LC), hot carcass (HCP) and cold carcass (CCP) yield in percentage can be visualized on Table 1.

TABLE 1 – Average results obtained for hot (HCW) and cold (CCW) carcass weight, loss after cooling percentage (LC), and hot (HCP) and cold (CCP) carcass yield in percentage.

Tabela 1 - Resultados médios obtidos para os pesos de carcaça quente (HCW) e fria (CCW), perdas no resfriamento (LC) e rendimento de carcaça quente (HCP) e fria (CCW) em porcentagem.

TREATMENT	HCW (Kg)	CCW (Kg)	LC (%)	HCP (%)	CCP (%)
T ₁	265.83	257.97	2.96	50.28	48.80
T ₂	267.67	260.92	2.91	51.20	48.81
T ₃	268.67	259.27	3.13	51.05	49.45

It can be verified that the treatment had no effect (P > 0.05) over these variables. It has been verified just a block effect over the average carcass weight, hot or cold, meaning that the heavier animals (Block 2: HCW=274.55 kg and CCW=266.63 kg) have shown significant higher average values (P < 0.05) than the lighter (Block 1: HCW=260.22 kg e CCW=252.13 kg). A treatment effect have not been observed (P > 0.05) over the

carcass length (CL), leg length (LL) and thigh thickness (TT). Just a block effect has been verified over the CL, meaning that, the heavier animals (Block 2: CL=136.00 cm) have shown a higher average for CL (P < 0.05) than the lighter (Block 1: CL=132.72 cm).

The averages for carcass (CL) and leg (LL) length, as well as for thigh thickness (TT), can be found at Table 2.

TABLE 2 – Observed averages for carcass (CL) and leg (LL) length, and for thigh thickness (TT) per treatment.

Tabela 2 - Médias observadas para o comprimento de carcaça (CL) e de perna (LL) e para a espessura de coxão por tratamento.

TREATMENT	CARCASS MEASURES (cm)		
	CL	LL	TT
T ₁	133.75	70.66	26.16
T ₂	133.50	71.33	26.25
T ₃	135.83	72.40	26.25

Comparing the obtained results, with those presented by literature, it can be verified the closeness of the values for LL and TT, has been

reported by Moletta, 1990; Moletta et al, 1993; Müller et al, 1994ab. However, the CL verified of the animals that have been used in this study, were hi-

gher than those reported by all the other authors in question, including those obtained by Lourenço Júnior, et al (1980), Oliveira; Velloso e Schalch (1991) and Gazzetta, et al (1995).

No treatment effect has been observed ($P > 0.05$) over the loin area (LA), loin area per 100

kg of live weight (LA/100 kg LW), or over the loin area per 100 kg of cold carcass (LA/100 kg CC), neither over the loin fat thickness (LF).

The average values for the loin area measures (LA) and loin fat thickness (LF) can be observed on Table 3.

TABLE 3 – Average values for *Longissimus dorsi* muscle area (LA) and loin fat thickness (LF).

Tabela 3 - Valores médios para a área (LA) e espessura de gordura (LF) do músculo Longissimus dorsi.

(1) Loin area /100 kg of cold carcass.

TREATMENT	CARCASS CHARACTERISTICS (AVERAGE)		
	LA (cm ²)	(1) LA/100 kg CC (cm ²)	LF (mm)
T ₁	65.48	25.37	7.58
T ₂	67.83	26.16	8.42
T ₃	62.76	24.20	6.88

The literature have shown that the obtained measures of LA and LF may vary among the different authors, because these characteristics may suffer genetic and environmental effects (diet, on the LF case), making the comparison among the authors not so valid.

Due to the observation that some animals had a more accentuated fat cover on the carcass, a correlation analysis has been done (r) of Live Weight at Slaughtering (LWS) and the Body Weight Gain (BWG) over the LF. The obtained results were not significant ($P > 0.05$) and a low correlation has been verified. The LWS and the BWG have presented $r = 0.17$ and $r = 0.09$, respectively, with the LF.

In order to evaluate the LA influence over the muscle percentage (MP) on the carcass, a correlation study has been done. Even though a positive correlation has been observed ($r = 0.46$), a significant effect has not been noted of LA over MP ($P > 0.05$). The obtained value was higher than the verified by Jorge et al, (1993b), who has obtained $r = 0.11$, also with no significant influence. It can be concluded than the LA has not shown itself as a reliable muscle indicator.

There has been no difference between the treatments ($P > 0.05$) for the muscle (MP) and fat (FP) percentages. However, a treatment influence has been verified ($P < 0.05$) over the carcass

bones percentage (BP). This was an unexpected fact, and can be explained due to the existence of two animals with heavier bones on treatment 3, providing, thus, the average raising of this characteristic. Although it is technically adequate, the number of replications per treatment (six animals) was restrict, and the animals were drawn in lots and blocked by weight. Therefore, the existence of just one animal with heavier bones could influence the raising of the significant average levels, what would be impossible to check before slaughtering the animals.

On the literature, it may be observed the most varied values for meat (MP), bone (BP) and fat (FP) percentage, what must be attributed to the different methodologies adopted by authors for their determinations. Many referential are used for the evaluations, such as: live weight, hot or cold carcass weight, part of the carcass where the determination has been done. These, besides the differences of the feed systems, age at slaughtering, breed and individual variations, influences the obtained results.

Table 4 presents the results obtained for muscle (MP), bone (BP) and fat (FP) percentage, for the treatments (the values have been converted to the equations proposed by Müller, et al (1973).

TABLE 4 – Carcass muscle (MP), bone (BP) and fat (FP) average percentage per treatment.
TABLE 4 - Porcentagem de músculos (MP), ossos (BP) e gordura (FP) nas carcaças, por tratamento.

TREATMENT	CARCASS CHARACTERISTICS (%)			
	MP	BP ^(*)	FP	RELATION MU : OS : FP
T ₁	56.47	16.06 b	27.85	5.6 : 1.6 : 2.8
T ₂	61.07	16.38 ab	22.73	6.1 : 1.6 : 2.2
T ₃	59.00	17.32 a	23.50	5.9 : 1.7 : 2.4

(*) Averages followed by different letters, on the column, differ significantly (P < 0.05), by Tukey test.

The results for the qualitative characteristics are subjective, and may vary due to the individual evaluation of each author. Although, there seems to be a certain equality between the obtained data of the present study and those presented in the literature, in other words, the buffaloes nor-

mally present a regular conformation, with marbling varying between light and traces, color to lightly dark, and texture to lightly rough.

In table 5 it is present the obtained data for the carcass qualitative characteristics of the confined animals, evaluated according to the methodology proposed by Müller (1987).

TABLE 5 – Averages for carcass qualitative characteristics per treatment (conformation-conf; marbling-MM; color-MC and texture-MT).

TABLE 5 - Médias para as características qualitativas das carcaças, por tratamento (conformação-conf; marmoreio - MM; cor - MC e textura - MT).

TREATMENT	QUALITATIVE CHARACTERISTICS (AVERAGE)							
	CONF		MM		MC		MT	
	P ^(*)	C ^(*)	P ^(*)	C ^(*)	P ^(*)	C ^(*)	P ^(*)	C ^(*)
T ₁	10.2	Good (-)	5.5	Light	3.7	LDR (1)	3.7	LGR (2)
T ₂	9.7	Regular (+)	5.3	Light	3.8	LDR (1)	3.5	LGR (2)
T ₃	9.3	Regular (+)	4.3	Light (-)	3.2	LDR (1)	3.7	LGR (2)

P ^(*)= Points; C ^(*)= Classification; (1) LDR = Lightly Dark Red; (2) LGR = Lightly Rough.

The obtained data over the evaluated qualitative characteristics of the carcasses has shown no treatment effect (P > 0.05).

In order to evaluate a possible interaction of the body weight gain (BWG) over the loin fat thickness (LF) and meat marbling (MM) on the carcasses,

due to the visual observation of a bigger fat cover in some of the carcasses, a correlation study have been carried on. It has been verified, however, that the BWG did not have a significant influence (P > 0.05) over the LF (r=0.09) or over the MM (r=0.18).

Conclusions

The use of different relations of roughage and concentrate for non-castrated male buffaloes, submitted to a confined system, on diets of the same protein and energy levels, at the trial conditions, have not influenced the productive performance of the animals, neither the carcass qualitative and quantitative characteristics.

There has been an effect of the weight at slaughtering, over the hot and cold carcass weight, and over the carcass length, what makes clear the superiority of the animals on block 2 (heavier) over the animals on block 1 (lighter).

Recommendations

a) Even considering that some papers demonstrates that the raising of the concentrate grade on the diet promotes the weight gain, it has to be emphasized that: the feed handling strategy for intensive meat production systems, must be evaluated economically, in order to obtain a better performance;

b) The concentrate feed, in practice, must have its production cost reduced, through the feed production at the farm.

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