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ENERGETIC VALUE OF FORAGES FROM SEMI-ARID REGION AND DIGESTIBILITY OF RATIONS FOR NAKED NECK PULLETS[1]

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ABSTRACT - The feeding programs for naked neck chickens in semi-intensive production system from brazilian equatorial semi-arid environment, must consider regional food availability and respective nutritional values. Thus, to evaluate the digestibility and metabolizable energy of alternative forages, it was used 240 naked neck pullets (Isa Label lineage) receiving water and ration *ad libitum*, pair-housed in cages for total collection of excreta on conventional warehouse. It was used a completely randomized design with factorial arrangement (5x2): one control ration (corn and soy meal) and other four experimental rations with silk flower hay (*Calotropis procera*), cassava leafs hay (*Manihot esculenta*), kills pasture hay (*Senna obtusifolia*) or leucaena leafs hay (*Leucaena leucocephala*), and all rations were balanced for two growing phases, between 8 and 10 weeks (young pullets) and between 14 and 16 weeks of age (old pullets). The values of apparent digestibility of nutrients for all experimental rations were lower than control ration (P <0.05) and it was observed general means of 72.18% for dry matter, 78.12% for crude protein, 66.90% for ether extract, 28.08% for neutral detergent fiber, 18.51% for the acid detergent fiber, 71.64% for gross energy and availability of 15.61% for mineral matter. The general mean of apparent and corrected metabolizable energy of alternative forages was 1217 kcal/kg and 1108 kcal/kg, respectively, and the higher value was determined for leucaena hay and the lower value for silk flower hay (P <0.05).

Keywords: Chickens. Energy. Foods. Fiber. Nutrition.

VALOR ENERGÉTICO DE FORRAGEIRAS DO SEMIÁRIDO E DIGESTIBILIDADE DE RAÇÕES COM FRANGAS DE PESCOÇO PELADO

RESUMO - Os programas de alimentação para aves de pescoço pelado em sistema de produção semi-intensivo no ambiente equatorial semiárido brasileiro, devem levar em consideração a disponibilidade de alimentos regionais e seus respectivos valores nutricionais. Assim, para avaliar a digestibilidade e a energia metabolizável de forrageiras alternativas, utilizaram-se 240 frangas da linhagem Isa Label recebendo água e alimento à vontade, alojadas aos pares em gaiolas metálicas para coleta total de excretas, e instaladas em um galpão convencional. Foi usado um delineamento inteiramente casualizado em esquema fatorial (5x2): uma ração controle (farelo de soja e milho) e outras quatro rações contendo feno de flor de seda (*Calotropis procera*), feno de maniva de mandioca (*Manihot esculenta*), feno de matapasto (*Senna obtusifolia*) ou feno de leucena (*Leucaena leucocephala*), sendo todas as rações balanceadas para duas fases de crescimento, entre 8 e 10 semanas (frangas, fase de cria) e entre 14 e 16 semanas de idade (frangas, fase de recria). Os valores de digestibilidade aparente dos nutrientes para todas as rações experimentais foram inferiores à ração controle (P<0,05), observando-se médias gerais de 72,18% para matéria seca, de 78,12% para proteína bruta, de 66,90% para extrato etéreo, de 28,08% para fibra em detergente neutro, de 18,51% para fibra em detergente ácido, de 71,64% para energia bruta e 15,61% para matéria mineral. A média geral de energia metabolizável aparente e corrigida para balanço de nitrogênio para forrageiras alternativas foi 1217 kcal/kg e 1108 kcal/kg, respectivamente, sendo determinado maior valor para feno de leucena e menor valor para feno de flor de seda (P<0,05).

Palavras-chave: Alimentos. Aves. Energia. Fibra. Nutrição.

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INTRODUCTION

The diversification of poultry production systems in farms in northeastern Brazil, in particular, the semi-intensive or free range poultry, has improvemed in productivity and sensorial quality of meat and eggs, adding values like animal welfare to cultural and environmental aspects. Technologies adapt for avian exploration in regional condition has provided advances on phenotype viability, for example, Isa Label lineage or naked neck chickens. Indeed, the feeding program represents most of the cost of semi-intensive poultry production, which makes it worth to investigate foods that can partially replace corn and soybean meal, as for insufficient agrindustrial availability as for the competition between humans and animals. In the equatorial semi-arid region, the use of alternative forage for free range poultry system still needs explaining regarding the effects of fiber or antinutritional factors on the availability of dietetic protein and energy (OLIVEIRA, 2005; COSTA et al., 2007).

Among the legumes cultivated in northeastern Brazil, leucaena (*Leucaena leucocephala*) has been highlighted by good levels of carotenoids, protein and energy; however, there is limitation to it due dietary fiber or concentration of mimosine (OLIVEIRA et al., 2000). Another legume empirically used in animal feed is kills pasture or “kills pasture” (*Senna obtusifolia*), a weed of pastures, which, after haying, has satisfactory acceptability and reduction of antinutritional factors like glycosides and tannins (NASCIMENTO et al., 2001). The cassava leafs (*Manihot esculenta*) after haymaking, maintains its nutritional value and reduces the phytotoxic substances through the volatilization of hydrocyanic acid and linamarin; however, the fiber propitiated by leaf and stem can influence the digestibility (NUNES IRMÃO et al., 2008). The silk flower (*Calotropis procera*) is very resistant to water stress, but it must be heat treated due to phytotoxic substances like alkaloids, glycosides and tannins affecting the acceptability and digestibility (MELO et al., 2001).

Aiming at a better knowledge on the nutritional value of the regional forages from equatorial semi-arid for free range poultry systems, the objective of this study was to evaluate the digestibility of nutrients and metabolizable energy of the silk flower, cassava leafs, kills pasture or leucaena hays in rations to fed naked neck pullets in two growing phases.

MATERIAL AND METHODS

The experiment was conducted at the Poultry Sector of the Federal Rural University of the Semi-Arid (UFERSA). The temperature and relative humidity inside the sheds during the experimental period were measured with digital thermohygrometer and the average stood at 27 °C and 67%, respectively. One day old Isa Label chicks were vaccinated against gumboro and marek diseases, and as they were one week old vaccinated against new castle and fowlpox diseases. The housing was made in traditional sheds, covered with ceramic tile, concrete floor and side walls with wire mesh (roof base) and side curtains. In the initial growing phase, it was used a conventional diet, infant-type feeders and drinkers, wood shavings on the floor, circles of protection and bell heating. After the sixth week of life, the chicks were selected by uniform manner based on body live weight (1200g ±60 g). The digestibility trial was conducted with 120 young pullets and 120 old pullets of Isa Label lineage (naked neck), pair-housed in metal cages (40x40x25 cm), adapted for excreta collection, fitted with nipple drinker and channel feeder. The completely randomized design was used in a 5x2 factorial scheme (ration x age), with replicates contend two birds in each unit. The total excreta collection carried out every 12 hours, following the period of adaptation on seven days and subsequent five days for total excreta collection, in wich the chickens receiving water and ration *ad libitum*, with the subdivision of growth phase: young pullets (8 to 10 weeks of age) or old pullets (14 to 16 weeks of age). Rations and excreta were weighed every day and frozen at -10 °C.

Table 1 shows the dietetic treatments which consisted of a control ration (CR) and other four experimental rations containing silk flower hay (SF - *Calotropis procera*), or cassava leafs hay (CL - *Manihot esculenta*), or kills pasture hay (KP - *Senna obtusifolia*) or leucaena leafs hay (LL - *Leucaena leucocephala*), by the substituting 20% (kg/kg) of corn and soybean meal in the CR ration for each forage hay, supplemented with vitamins and minerals. The rations were formulated with recommendations for slow growing hens by Rostagno (2005), considering the young pullets (YP) or old pullets (OP). Table 2 shows the energetic and chemical composition of the forage hays, which were performed following methodologies described by Silva & Queiroz (2002) for dry matter (DM), ash (MM), ether extract (EE), neutral detergent fiber (NDF), acid detergent fiber (ADF), crude protein (CP) and gross energy (GE). The same analytical techniques were used in foods and excreta, and thus, it was determined the apparent digestibility, the coefficients of metabolization, metabolizable energy of the rations and of each forage hay by Matterson method (SAKOMURA; ROSTAGNO, 2007). For the growth phase of the pullets and chickens, the constant energy in the correction of apparent metabolizable energy for nitrogen retention (AMEn) was 8.22 kcal / g N in the uric acid form (ALBINO et al., 1992). For statistical analyzing variance and testing means (5%

probability) was used the SAEG - Statistical and Genetics Analysis System.

Table 1. Ingredients and nutrients composition of the control ration (CR), silk flower hay ration (SF), cassava leafs hay ration (CL), kills pasture hay ration (KP) or leucaena leafs hay ration (LL), for the young pullets (YP) and old pullets (OP) of naked neck lineage (Isa Label)

	CR		**SF**		**CL**		**KP**		**LL**	
	YP	**OP**	**YP**	**OP**	**YP**	**OP**	**YP**	**OP**	**YP**	**OP**
Silk Flower hay, kg	-	-	20.0	20.0	-	-	-	-	-	-
Cassava Leafs hay , kg	-	-	-	-	20.0	20.0	-	-	-	-
Kills Pasture hay , kg	-	-	-	-	-	-	20.0	20.0	-	-
Leucaena Leafs hay, kg	-	-	-	-	-	-	-	-	20.0	20.0
Corn grain milled, kg	70.0	75.0	55.0	60.0	55.0	60.0	55.0	60.0	55.0	60.0
Soybean Meal, kg	26.0	21.0	21.0	16.0	21.0	16.0	21.0	16.0	21.0	16.0
Dicalcic Phosphate, kg	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0
Limestone, kg	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
Salt, kg	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5
Supplement VM(1), kg	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5
Dry Matter, %	87.1	87.1	84.5	84.4	84.2	84.1	84.4	84.3	84.6	84.5
Mineral Matter, %	2.4	2.2	5.3	5.1	3.7	3.5	3.2	2.9	3.4	3.2
Etereal Extract, %	3.0	3.1	3.4	3.5	2.9	3.0	2.9	3.0	3.0	3.1
Neutral Det. Fiber, %	11.7	11.5	17.7	17.5	20.9	20.8	20.0	19.9	19.1	18.9
Acid Det. Fiber, %	4.1	4.0	9.8	9.6	11.5	11.4	9.7	9.6	8.6	8.4
Crude Protein, %	17.5	15.7	16.3	14.4	16.2	14.3	16.4	14.6	17.5	15.7
Gross Energy (2)	3633	3955	3725	4233	3680	4188	3729	4295	3714	4253

(1) guarantee levels per kg of product: vitamin A 10 million IU, vitamin D 2 million IU, vitamin E 30000 IU, vitamin K 3.0 g, thiamine 2.0 g, riboflavin 2.0 g, pyridoxine 6.0 g, cobalamin 1.5 g, pantothenic acid12 g, folic acid 1.0 g, biotin 1.0 g, niacin 50 g, BHT 5.0 g, copper 20 g, iron 100 g, iodine 2.0 g, manganese 160 g, selenium 0.25 g, zinc 100 g, vehicle inert for 1000g. (2) kcal/kg.

Table 2. Energy and chemical composition of the forage hays from semi-arid region (Brazil)

	Silk Flower	**Cassava Leafs**	**Kills Pasture**	**Leucaena Leafs**
Dry Matter, DM %	89.31	87.80	88.87	89.65
Mineral Matter, MM %	16.90	8.73	6.04	7.27
Etereal Extract, EE %	5.51	2.94	2.74	3.50
Neutral D. Fiber, NDF %	42.13	58.37	53.75	49.05
Acid D. Fiber, ADF %	32.45	41.24	32.26	26.49
Crude Protein, CP %	11.20	10.80	12.10	17.50
Gross Energy, GE kcal/kg	3828.00	4408.00	4309.00	4892.00

RESULTS AND DISCUSSION

The results showed no significant interaction (P> 0.05) on apparent digestibility of ethereal extract (EE), neutral and acid detergent fiber (NDF and ADF), crude protein (CP) and ash (MM) for experimental rations containing silk flower hay (SF), or cassava leafs hay (CL), or kills pasture hay (KP) or leucaena leafs hay (LL), to young and old pullets (YP and OP) of Isa Label lineage (naked neck) in the growing phase. However, there was significant interaction (P <0.05) on apparent digestibility of dry matter (DM) and gross energy (GE) between experimental rations and growing phase, and consequently, showed a significant interaction (P <0.05) on the values of apparent metabolizable energy (AME).

The reduction in digestibility of CP, EE and MM of the experimental rations with forages hays in relation to the control ration can be justified by the greater involvement of the fibrous components and their physical and chemical effects on the digestive tract of the chickens, for example, retention time, endogenous losses, mineral chelating and intestinal viscosity, and thus, effectively changing the digestion and absorption of nutrients (CARRE et al., 1995; OLIVEIRA et al., 2000; SILVA et al., 2000; DILGER et al., 2004). In Table 3, the reduction in digestibility of the proteins was lower for LF ration, intermediate for KP or CL ration, and significantly reduced for SF ration. This effect is not due only to the quantity and quality of forage protein, but also to astringent action of tannins on intestinal environment (NYACHOTI et al., 1997). Moreover, differences on digestibility of the lipids may be amplified by the accumulation of carotenoids in the excreta of the chickens.

The qualitative aspect of the fiber involves the nature and location of nutritional biomolecules in the plant cell wall, especially by the lignification effect on nutritional interactions; but, despite the remarkable negative effect in the digestibility brought about the dietetic inclusion of forages, there was no significant interaction in the digestibility of the fiber for the YP and OP phases, which allows to infer on efficiency limitation from intestinal symbiosis in relation to the physiological maturity of the digestive tract in the chickens (LEESON; SUMMERS, 2001; MACARI et al., 2002; SHAKOURI et al., 2006; ARAÚJO et al., 2008). In Table 3, the digestibility of the fiber was higher in the control ration compared to the experimental rations (SF, CL, KP or LF); however, despite the increase quantity of dietary fiber, there was no statistical difference in NDF digestibility between LF and KP ration, and there was no statistical difference in ADF digestibility between LF, KP and CL rations, which were much higher SF ration. The digestibility of the fiber enables an inference on different intensities of caecal microbial activity from the availability of pectin, hemicellulose and cellulose, and also to the lignification magnitude of these substrates (ARRUDA, 2011).

Table 3. No significant interaction (P> 0.05) of apparent digestibility for control ration (CR), silk flower hay ration (SF), or cassava leafs hay ration (CL), kills pasture hay ration (KP) or leucaena leafs hay ration (LL) for young (YP) and old pullets (OP) of naked neck lineage

Digestibility	Rations					Phases	
	CR	**SF**	**CL**	**KP**	**LL**	**YP**	**OP**
MM (%)[1]	20.84[a]	6.54[d]	15.40[c]	16.37[c]	18.92[b]	15.21[b]	16.01[a]
CP (%)[2]	88.46[a]	62.20[d]	77.62[c]	78.63[c]	80.69[b]	77.99[a]	78.25[a]
EE (%)[3]	83.52[a]	57.26[d]	61.79[c]	62.36[c]	69.57[b]	65.47[b]	68.33[a]
NDF (%)[4]	32.54[a]	18.45[c]	29.65[b]	28.71[ab]	31.05[ab]	27.89[a]	28.27[a]
ADF (%)[5]	23.11[a]	9.43[c]	19.90[b]	18.38[b]	21.73[b]	18.32[a]	18.71[a]

[a, b, c, d] _ Means followed by same letter do not differ statistically by Tukey test (P <0.05)
[1]– means for mineral matter (15.61%), coefficient of variation (9.48%), standard deviation (± 5.16)
[2]– means for crude protein (78.12%), coefficient of variation (3.45%), standard deviation (± 7.63)
[3]– means for ethereal extract (66.90%), coefficient of variation (2.92%), standard deviation (± 9.57)
[4]– means for neutral detergent fiber (28.08%), coefficient of variation (7.26%), standard deviation (± 5.37)
[5]– means for acid detergent fiber (18.51%), coefficient of variation (8.15%), standard deviation (± 5.06)

It was observed that apparent digestibility of energy for experimental rations, which were determinant for the ME values of the same, showed a significant interaction (P <0.05), possibly due to nutritional interactions on the rate of passage through the digestive tract, endogenous excretion and intestinal viscosity promoted by the substitution in 20% of the RCO for each forage hay tested in the growth phase (assessment methodology). In Table 4, it is assumed that quantity and quality of fibrous components of forages influenced the physical and chemical aspects of digestion and intestinal absorption, resulting in different efficiencies for energy metabolism (BRUM et al., 2000; FREITAS et al., 2006; COSTA et al., 2007).

The apparent metabolizable energy (AME) and metabolizable energy corrected for nitrogen retention (AMEn), individualized for each forage hay offered to the young and old pullets, showed significant interaction (P <0.05) similarly to the digestibility of energy in the rations. In Table 5, by comparing the means of metabolism coefficients and metabolizable energy for each forage hay, it can be highlighted the superiority of leucaena hay, followed by cassava leafs and kills pasture hays, and the significant inferiority for the silk flower hay. Thus, it can be reinforced the influence of the food composition in relation to the digestive efficiency of the young and old pullets, involving nutritional interactions, physiological adaptations and symbiotic microbial activity (NERY et al., 2007; MELLO et al., 2009; CALDERANO et al., 2010).

Table 4. Significant interaction (P> 0.05) of apparent digestibility for control ration (CR), silk flower hay ration (SF), cassava leafs hay ration (CL), kills pasture hay ration (KP) or leucaena leafs hay ration (LL), for young (YP) and old pullets (OP) of naked neck lineage.

	CR		SF		CL		KP		LL	
	YP	OP	YP	OP	YP	OP	YP	OP	YP	OP
DMD[1]	84.13[a]	83.29[a]	62.84[e]	56.31[f]	73.36[c]	69.89[d]	73.20[c]	69.10[d]	76.59[b]	72.26[c]
GED[2]	82.01[a]	83.09[a]	58.95[d]	60.20[d]	70.45[c]	72.21[b]	70.06[c]	71.82[b]	72.54[b]	74.04[b]
MAE[3]	2980[c]	3298[a]	2200[e]	2600[d]	2595[d]	3173[ab]	2610[d]	3181[ab]	2694[d]	3267[ab]

[a, b, c, d] _ Means followed by same letter do not differ statistically by Tukey test (P <0.05)
[1] dry matter digestibility, general mean (72.18%), coefficient of variation (3.60%), standard deviation (± 7.14)
[2] gross energy digestibility, general mean (71.64%), coefficient of variation (3.98%), standard deviation (± 8.40)
[3] apparent metabolizable energy of the experimental rations, general mean (2876 kcal/kg), coefficient of variation (4.12%), standard deviation (± 354.62)

Table 5. Significant interaction (P<0.05) for the metabolizable energy coefficients and values for all forages hays offered for the young (YP) and old pullets (OP) of naked neck lineage

	Silk Flower		Cassava Leafs		Kills Pasture		Leucaena	
	YP	OP	YP	OP	YP	OP	YP	OP
EMC [1] (%)	11.26[c]	13.97[c]	28.63[b]	31.60[b]	28.95[b]	32.05[b]	35.87[a]	38.40[a]
AME [2] (kcal/kg)	422.94[c]	524.36[c]	1259.30[b]	1390.20[b]	1223.36[b]	1354.33[b]	1720.84[a]	1841.27[a]
AMEn [3] (kcal/kg)	385.17[c]	477.54[c]	1146.87[b]	1266.15[b]	1114.13[b]	1233.41[b]	1567.21[a]	1676.87[a]

[a, b, c] _ Means followed by same letter do not differ statistically by Tukey test (P <0.05)
[1] metabolizable energy coefficient, mean for all forages hays (27.59%); coefficient of variation (4.80%); standard deviation (± 9.82)
[2] apparent metabolizable energy, mean for all forages hays (1217.09 kcal/kg); coefficient of variation (5.25%); standard deviation (± 507.74)
[3] apparent metabolizable energy corrected for nitrogen excretion, mean for forages hays (1108.42 kcal/kg); coefficient of variation (5.71%); standard deviation (± 490.89)

The semi-arid alternative forages have a diverse concentration of antinutritional substances, which may cause adverse effects on digestibility by the enzyme inhibition or unavailability of nutrients. Thus, the haymaking proved to be a minimizing process of the concentration or effects of these phytotoxic substances in the diet of chickens, as showed in leucaena mimosine levels (OLIVEIRA et al., 2000), cassava linamarin and hydrocyanic acid levels (NUNES IRMÃO et al., 2008), kills pasture glucosinolates and tannins levels (Nascimento et al., 2001); however, it showed to be inefficient to mitigate the concentration of phytotoxic substances or antinutritional effects of glycosides, triterpenes, alkaloids, polyphenols or tannins presents in the latex from stem and leaves of silk flower (MELO et al., 2001). The dietary use of semi-arid alternative forage in accordance to semi-intensive systems for poultry production depends on the vegetative maturity, stem and leaf relationship, haymaking process, and regional availability. Although the fiber fraction of forages has been responsible for the reduction in digestibility and metabolizable energy of rations, it was demonstrated feasibility for naked neck pullets with restriction or limitation. Aiming at productivity and quality, it is suggested a preference for leucaena hay and cassava leafs hay for Isa Label pullets, some caution for the use of kills pasture hay and appropriate combination in smaller quantities. It was not demonstrated viability for the silk flower because of the negative expectation on nutritional effects and probable physiological abnormalities in the digestive tract of the young and old pullets.

CONCLUSION

The 20% of alternative forages hays to fed naked neck pullets decreased nutrient digestibility and energy metabolizable of the rations, and verified lower values for young pullets and higher values for old pullets. The apparent metabolizable energy showed significant differences among the forages hays, and observed better results with leucaena hay, intermediate values for kills pasture hay and cassava leafs hay, and worst results for the silk flower hay for both growth phases of the naked neck pullets in this study.

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