



Performance, carcass yield, and meat quality of free-range broilers fed wet grain corn silage

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ABSTRACT

This study aimed at evaluating the effect of total replacement of dry corn by wet grain corn silage (WGCS) in the feed of label broilers older than 28 days of age on performance, mortality, carcass, parts, breast meat and thighs meat yields, and meat quality. A mixed-sex flock of 448 ISA S 757-N (naked-neck ISA JA Label) day-old chicks was randomly distributed in to randomized block experimental design with four treatments (T1 – with no WGCS; T2 – WGCS between 28 and 83 days; T3 – WGCS between 42 and 83 days; and T4 – WGCS between 63 and 83 days) and four replicates of 28 birds each. Birds were raised under the same management and feeding conditions until 28 days of age, when they started to have free access to paddock with pasture (at least 3m²/bird) and to be fed the experimental diets. Feed and water were offered *ad libitum* throughout the rearing period, which was divided in three stages: starter (1 to 28 days), grower (29 to 63 days), and finisher (64 to 83 days) according to the feeding schedule. During the short periods of WGCS use (group T2 during grower stage and T4 during the finisher stage), performance and mortality results were similar as to those of the control group (T1). At the end of the experiment, it was observed that the extended use of WGCS (T2 and T3) determined a negative effect on feed conversion ratio. However, the best results of breast meat yield were observed with birds fed WGCS since 28 days (T2). It was concluded that WGCS can replace dry corn grain for short periods during the grower and finisher stages with no impairment of meat quality and yield in slow growth broilers.

INTRODUCTION

The poultry business is one of the most important economic industries of Brazilian agriculture, having an outstanding position on the national and international market. In Brazil, broiler production is predominantly industrial. An alternative for the small farmer that wishes to enter this industry is to raise label chickens, which designation is due to their specific genetic lines. These birds are fed diets free from antibiotics, anticoccidials, growth promoters, chemical therapeutic agents, as well as free from animal raw materials. Label birds are raised under free-range or semi-extensive systems, with access to grass pastures, which gives a different flavor to their meat. There is an increasing demand for label chicken meat in the market as the public is becoming stricter and is looking for less industrialized product.

Feed costs represent approximately 70% of total production costs. The inclusion of alternative ingredients in label chicken feeds aims at reducing feed costs, thereby making this kind of business more attractive to small farmers. In poultry production, particularly in broiler production, the main ingredient used in feeds as energy is corn (*Zea mays*), which



may account for 60% of the total feed amount, and approximately 40% of feed cost (Zanotto *et al.*, 1996).

A technique recently research in poultry feeding, as well as in other farm animals, is the replacement of dry corn by wet grain corn silage (WGCS) in feeds. According to Majowski (2002), WGCS is starting to be used in almost every swine producing region of Brazil, and may represent up to 20% reduction in feed costs. Costa *et al.* (1999) and Jobim *et al.* (2001) mention several studies carried out mostly in the USA, which demonstrate some performance and economic advantages of the use of WGCS in ruminant diets.

The technique for obtaining this silage consists in harvesting corn with high humidity, of approximately 28%, immediately after physiological maturation. This period represents the end of nutrient translocation from the plant to the grains, when these have maximum levels of starch, protein, and oil. WGCS is the result of anaerobic fermentation of ground and compacted corn mass.

There are several advantages of preserving wet corn grain as silage in swine production, mainly feed cost reduction, as there are no costs for transporting corn to the feed mill and back to farm, it avoid losses due to humidity, impurities, and spoilt grains, in addition to corn drying costs, and storage costs and taxes. Costa *et al.* (1998), discussing cereal grain preservation for animal feed, observed that wet grain corn silage is 11% less expensive as compared to dry grains, as it eliminates grain pre-processing stages of cleaning and drying.

A further advantage is the anticipation of the harvest in three to four weeks, allowing other crop to be planted in the same area, thereby maximizing land use and reducing both quantitative losses due to lower plant damping-off and qualitative losses caused by bird, fungi, and insect attack (Costa *et al.*, 1999).

It must be stressed that wet grain corn silage must only be mixed with the other feed ingredients immediately before the feed is offered, as otherwise there can be spoilage, lower feed intake, and impaired performance (Berto *et al.*, 2001). This is one of the limitations of the use of this technique.

According to Penz (1993), the use of WGCS in poultry feeds inhibits the proliferation of undesirable enterobacteria, and boosts nutritional gains as it increases nutrient availability. WGCS contains short chain fatty acids (SCFA) produced by anaerobic microbial fermentation, which are responsible for pH reduction and silage conservation. As antibiotic growth promoters and anticoccidials are not allowed in label

chicken feeds, SCFA present in the WGCS included in feeds may replace these additives. Several authors have studied the inclusion of organic acids in broiler feeds to improve performance (Garcia *et al.*, 1999) and carcass yield (Samanta & Biswas., 1995).

Several authors worked with the inclusion of organic acids in order to enhance performance and carcass yield, as well as to inhibit the proliferation on undesirable enterobacteria in the digestive tract of birds (Waldroup *et al.*, 1995) and the development of fungi during wet grain and feed storage (Garlich *et al.*, 1976). However, there are limitations to the use of these acids, such as high cost and operational hindrances, as they are extremely irritating to the skin, difficult to handle, and corrosive to the equipment (Vale, 1998). Therefore, the used of WGCS may be an alternative to the inclusion of organic acids in poultry and swine diets, as, according to Jobim (1996), WGCS contains about 0.91% organic acids in its composition in dry matter percentage, with 0.78% lactic acid, 0.12% acetic acid, 0.005% propionic acid, and 0.003% butyric acid.

Animals fed WGCS present better feed conversion ratio, which is reflected in lower production cost, as observed by Lopes (2000) in swine, and Costa *et al.* (1999) in feedlot cattle. Hunt *et al.* (1997) worked with the inclusion of up to 40% wet grain corn silage replacing dry grains in broiler and turkey diets, on the same dry matter basis, and obtained better feed conversion ratios with inclusion levels of 8 and 16%. Replacement of 60% (Gonçalves, 2003) and 50% (Andrade, 2004) of dry corn by WGCS did not compromise performance, carcass yield, and parts yield of broilers.

This study aimed at evaluating the effect of total replacement of dry corn by wet grain corn silage in label chicken feeds on performance, carcass yield, parts yield, and meat quality.

MATERIAL AND METHODS

The experiment was carried out in the experimental facilities of the Unit of Research and Development of Brotas – DDD/APTA Regional Centro-Oeste, of the Department of Agriculture and Supply of the state of São Paulo, from August, 9th to November, 2nd 2004.

A straight-run flock of 448 ISA S 757-N (ISA JA Label naked neck) day-old label chicks was distributed according to a random block experimental design with four treatments, and four replicates each. Treatments were as follows:

T1 - no silage.



- T2 - wet grain corn silage – supplied in the period of 28-83 days of age.
- T3 - wet grain corn silage – supplied in the period of 42-83 days of age.
- T4 - wet grain corn silage – supplied in the period of 63-83 days of age.

Birds were housed in experimental masonry houses with mud tiles, 2.8 roof height, divided in 5.0 m² pens. Pens had access to a 135m² paddock area planted with *Brachiaria decumbens*, limited by a wire mesh. Each pen was equipped with an automatic bell drinker, and a semi-automatic tube-type feeder.

Chicks were vaccinated at the hatchery for Marek disease. They received in-feed vaccination for coccidiosis at housing, and were vaccinated at 15 days of age for fowl pox.

Chicks were reared under the same management and feeding conditions until 28 days of age, when they were provided free access to the paddock (3m²/bird) and to be fed the experimental diets.

Feed and water were offered *ad libitum* during the entire rearing period. The feeding program was divided in three phases: starter diet (1 to 28 days), grower diet (29 to 63 days), and finisher diet (64 to 83 days), according to the recommendations of Figueiredo (2000). Feed composition in percentage and calculated values are shown in Table 1.

Table 1 – Feed composition (%) and calculated values.

Ingredient	1 to 28 days	29 to 63 days	64 to 84 days
Corn	60.916	66.570	72.820
Soybean meal	34.547	29.084	23.494
Dicalcium phosphate	1.869	1.738	1.497
Limestone	1.062	1.187	1.254
Soybean oil	0.763	0.572	0.100
Salt	0.350	0.350	0.350
DL-methionine	0.093	0.099	0.085
Vitamin supplement ¹	0.100	0.100	0.100
Mineral supplement ²	0.100	0.100	0.100
Simbiótico plus ³	0.200	0.200	0.200
Total	100.0	100.0	100.0
Calculated values			
ME kcal/kg	2.800	2.900	2.900
CP, %	20.00	18.00	16.50
Lysine, %	1.00	0.88	0.78
Methionine, %	0.40	0.38	0.35
Calcium, %	1.00	1.00	0.95
Available phosphorus, %	0.46	0.43	0.38

1 - Suplemento Vitamínico: Vit. A – 1,500,000 UI; Vit. D3 – 500,000UI; Vit. E – 3,000 mg; Vit. K3 – 200 mg; Thiamin – 250 mg; Riboflavin – 1,125 mg; Pyridoxine – 375 mg; Vit. B12 – 3,000 mg; Niacin – 7,500 mg; Calcium pantothenate – 2,500 mg; Folic acid – 1,375.5 mg; Biotin – 12.5 mg; Choline chloride – 81,250 mg; Methionine – 325,000 and Antioxidant – 5,000 mg. Guaranteed levels per kg product. 2 - Suplemento Mineral: Iron – 5,000 mg; Copper – 70,000 mg; Manganese – 60,000 mg; Zinc – 50,000 mg; Iodine – 1,250 mg and Selenium – 200 mg. Guaranteed levels per kg product. 3 - Simbiótico plus: 10⁶ UFC de *Enterococcus* sp per gram of product and 85% de mannanoligoscharides.

Feeds were produced in the meal form, and were free from chemical growth promoters, and animal ingredients. The experimental diets consisted in the complete substitution of dry corn by wet grain corn silage, taking into consideration the moisture content of these ingredients in order to maintain the same amount of corn dry matter in the feeds. Corn and silage dry matter content were 88% and 69.35%, respectively, using a correction factor of 1.269 for the replacement of dry corn by silage. The silage was prepared in 200kg plastic drums with screw lids.

Feed intake was daily estimated, and the experimental diets were also daily prepared mixing WGCS to the other feed ingredients in a “Y” 100-kg mixer for 10 minutes. Feed residues of the previous day were daily weighed, and then disposed.

Final weight, weight gain, feed intake, feed conversion ratio, and mortality were calculated for each phase. Average feed intake was corrected considering the average number of birds during the analyzed period. The calculation of the feed conversion ratio took into consideration the weight of birds that died during the period.

At 84 days of age, samples of 6 birds per experimental unit (3 females and 3 males) were taken, being 12 females and 12 males per treatment, summing up 96 birds. Birds were slaughtered in the Experimental Slaughterhouse of FMVZ – UNESP, Botucatu campus - SP, for carcass yield, parts yield, and meat quality. Before slaughter, birds were submitted to feed fasting for 8 hours.

Carcass yield (with no feet, head, neck, and viscera), parts yield (breast, legs, wings, back, and abdominal fat) and breast and leg meat data were obtained. Abdominal fat was considered as the fat present in the region of the vent, and that attached to the gizzard.

Carcass yield calculation was based on live weight, which was individually measured in the plant, and parts yield was calculated based on carcass weight. Yield data were evaluated according to the methodology described by Mendes (1990).

In order to evaluate meat quality, breast meat samples were collected and analyzed for temperature, pH, cooking losses (CL), and shearing strength (SS).

The results were submitted to analysis of variance using GLM (General Linear Models) procedure of the statistical software SAS (SAS, 1996), and the means were compared using the test of Tukey.



RESULTS AND DISCUSSION

Average performance results for the period of wet grain corn silage in the feed (from 28, 42, and 63 days of age), are shown in Table 2.

There were no significant differences ($p>0.05$) among treatments for final weight and weight gain, that is, results of feeds with dry grains or with wet grain corn silage were similar. However, Sartori *et al.* (2002) when evaluating the supply of WGCS in broiler feeds, reported that birds fed silage for 42 days of rearing had worse live weight and weight gain as compared to those fed dry grain corn. Similar results were obtained by Martins *et al.* (2000) and Carrijo *et al.* (2000). Live weight reduction was also observed by Andrade *et al.* (2004), who evaluated the inclusion of WGCS (0 and 50%) in the feed of broilers reared until 49 days of age.

Feed intake was significantly different ($p<0.05$) in the period between 28 and 63 days of age, when birds fed wet grain corn silage, independent from the treatment, presented higher feed intake. However, these differences were not significant when the total period of inclusion was analyzed total (28 to 83 days). Carrijo *et al.* (2000) and Sartori *et al.* (2002) evaluated feed intake of broilers, using fresh matter, and also found higher feed intake in birds fed wet grain corn silage, as a function of the high moisture content. However, when fitting the data for the dry matter content of dry corn (88%), Carrijo *et al.* (2000) observed that feed intake was lower for birds fed WGCS as compared to those fed dry corn.

Martins *et al.* (2000) and Carrijo *et al.* (2000) suggested that the complete replacement of dry corn by wet grain corn silage physically limited the digestive tract in terms of feed intake due to the high moisture content of these feeds.

Considering the period of 28-83 days, when only the control diet did not include WGCS, it was observed that feed conversion ratio (FCR) was worse ($p<0.05$) for the groups that receive silage from 28 days (T2) or 42 days (T3). However, feeding birds with WGCS only during the grower (28 to 42 days) or the finisher (63 to 83 days of age) periods did not impair performance. Similar results were obtained by Sartori *et al.* (2002), who observed worse FCR ($P<0.05$) in birds fed WGCS as compared to those fed dry corn. This is in disagreement with Carrijo *et al.* (2000), who found better FCR for the WGCS diet as compared to the dry corn diet. Hunt *et al.* (1997) worked with WGCS inclusion levels of up to 40%, on dry matter basis, in broiler and turkey feeds, and found better FCR with the WGCS diets, with the best results obtained with 8 and 16% inclusion levels.

There was no difference among treatments ($p>0.05$) as to mortality.

At 84 days of age, it was verified that, except for breast meat yield, there was no effect of the treatments on carcass yield, parts yield, and abdominal fat (Table 3). As to breast meat yield, T2 birds had the best results ($p<0.05$) as compared to the other treatments, but those were not different from the treatments receiving silage for less time (T4). Andrade *et al.* (2004) replaced

Table 2 - Final weight (FW), weight gain (WG), feed intake (FI), feed conversion ratio (FCR), and mortality of label chickens fed wet grain corn silage.

Period	Treatment	FW (g)	WG (g)	FI (g)	FCR	Mort. %
28-42 d	T1	960.71	420.53	1177.23	2.80	0.00
	T2	962.05	431.69	1178.88	2.73	0.00
	T3	952.33	414.78	1178.75	2.81	0.89
	T4	938.55	411.80	1150.05	2.79	0.89
	Mean	953.41	419.70	1171.23	2.78	0.44
	CV*	4.24	5.61	3.37	3.97	298.14
28-63 d	T1	1598.50	1058.03	3077.88 b	2.88 b	1.79
	T2	1570.09	1039.73	3300.94 ab	3.18 a	0.00
	T3	1570.60	1038.05	3311.31 a	3.20 a	0.89
	T4	1557.11	1035.58	2970.30 b	2.88 b	1.79
	Mean	1574.07	1036.60	3165.10	3.03	1.11
	CV*	5.24	6.56	5.15	3.46	201.33
28-83 d	T1	2060.17	1509.71	5139.24	3.38 b	1.79
	T2	2087.67	1552.35	5632.53	3.60 a	0.89
	T3	2073.18	1530.37	5640.08	3.65 a	1.79
	T4	2025.82	1494.30	5207.40	3.47 ab	1.79
	Mean	2061.71	1521.68	5404.81	3.53	1.56
	CV*	5.81	6.48	5.64	2.61	158.22

a, b in the same column are statistically different by the test of Tukey ($p<0.05$). T1 - no silage; T2 - wet grain corn silage – supplied in the period of 28-83 days of age; T3 - wet grain corn silage – supplied in the period of 42-83 days of age; T4 - wet grain corn silage – supplied in the period of 63-83 days of age. *Coefficient of Variation.



50% dry corn for WGCS in broiler feeds, and observed significant differences only for breast skin, leg skin, and abdominal fat. When 100% dry corn was replaced by WGCS in broiler diets during an experimental period of 42 days of rearing, no significant differences were found in carcass yield (Carrizo *et al.*, 2000 and Sartori *et al.*, 2002) and parts yield (Sartori *et al.*, 2002).

Table 3 - Carcass yield, parts yield, and abdominal fat of label chickens fed wet grain corn silage.

Yield (%)	Treatments				Sex	
	T1	T2	T3	T4	Male	Female
Carcass	70.38	70.57	71.06	70.66	70.99	70.35
Breast	30.94	31.51	30.39	30.35	30.30b	31.29a
Breast meat	21.06b	22.17a	21.01b	21.28ab	20.89b	21.87a
Legs	34.41	33.33	33.79	33.71	34.89a	32.73b
Wings	12.47	12.51	12.44	12.91	12.49	12.68
Back	21.24	21.50	21.68	22.14	21.49	21.80
Abdominal fat	2.86	2.56	2.46	2.73	2.27b	3.04a

a,b in the same column are statistically different by the test of Tukey ($p < 0.05$). T1 - no silage; T2 - wet grain corn silage – supplied in the period of 28-83 days of age; T3 - wet grain corn silage – supplied in the period of 42-83 days of age; T4 - wet grain corn silage – supplied in the period of 63-83 days of age.

There was an effect of sex, with females presenting higher ($p < 0.05$) breast yield, breast meat yield, and abdominal fat, but they presented lower leg yield. Takahashi (2003) also observed this difference in behavior between male and female label chickens.

There was a treatment x sex interaction for leg yield ($p < 0.05$). This interaction is detailed in Table 4. As to the effect of sex in each treatment, it was observed that males had better yield as compared to females, when receiving diets that included WGCS, but there were no difference when the control diet was fed. In terms of the effect of treatments within each sex, leg yield of T3 females was lower than those in the control group (T1). There was no effect on leg yield when males were fed WGCS ($p > 0.05$).

Table 4 - Leg meat yield according to sex and treatment of label chickens fed wet grain corn silage.

Treatment	Male	Female	Average
T1	22.54	21.66 A	22.10
T2	21.99 a	20.44 AB b	21.22
T3	22.97 a	19.92 B b	21.45
T4	21.81 a	20.76 AB b	21.29
Average	22.33	20.70	

a,b in the same column are statistically different by the test of Tukey ($p < 0.05$). T1 - no silage; T2 - wet grain corn silage – supplied in the period of 28-83 days of age; T3 - wet grain corn silage – supplied in the period of 42-83 days of age; T4 - wet grain corn silage – supplied in the period of 63-83 days of age.

Table 5 shows the results of meat quality parameters, which did not present significant differences ($P > 0.05$) among treatments. There was

significant difference ($P < 0.05$) in terms of sex for shearing strength, with females presenting a more tender meat.

CONCLUSION

It was concluded that the use of wet grain corn silage can replace dry corn during short periods of the grower and finisher phases, with no impairment of meat yield and quality of slow-growing broilers.

Table 5 - Mean results of meat quality assessment of male and female label chickens fed wet grain corn silage (WGCS).

Variation factor	WGCS				SEX		
	T1	T2	T3	T4	Male	Female	Mean
Temperature	8.66	8.82	9.82	8.75	9.04	8.98	10.34
pH	5.85	5.89	5.96	5.91	5.91	5.89	1.33
PPC	19.26	17.80	17.81	16.93	18.00	17.90	12.38
SS	3.20	3.24	3.43	3.35	3.61 a	3.00 b	14.25

a,b in the same column are statistically different by the test of Tukey ($p < 0.05$). T1 - no silage; T2 - wet grain corn silage – supplied in the period of 28-83 days of age; T3 - wet grain corn silage – supplied in the period of 42-83 days of age; T4 - wet grain corn silage – supplied in the period of 63-83 days of age.

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