Arch. Tierz., Dummerstorf 40 (1997) 3, 277-286

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Effect of Sorghum in Diets for Ducks*

Summary

Two experiments were carried out during one year to evaluate growth metabolic profiles and carcass characteristics of Italian local strains of Muscovy duck males (**MD**) and Common duck females (**CD**) fed with diets containing sorghum. In the first trial the ducks were fed *ad libitum*, from day old to slaughtering age, three experimental isoenergetic and isoproteic diets, diet A (corn based diet), diet B (half corn and half high tannin sorghum - **HTS**), diet C (**HTS** - based diet). In the second trial ducks were fed *ad libitum*, from day old to slaughtering age, three experimental isoenergetic diets, diet A1 (corn based diet), diet B1 (low tannin sorghum - **LTS** plus, 1.5 g/Kg, starter, or 2.5 g/Kg, finisher, of dl-metionine) diet C1 (50% low tannin sorghum - **LTS** - with 50% **HTS** plus, 1.5 g/Kg, starter, or 1.5 g/Kg, finisher, of dl-metionine). Individual live weights and feed consumption were recorded weekly per pen, plasma samples were drawn at slaughter age, carried out at 11 weeks for **MD** and 8 weeks old for **CD**.

In the first trial live weights of **MD** and **CD** fed with diet C were lower than live weights of birds fed with the other two diets (**MD**: 2053g *vs.* 3537g and 3000g; **CD**: 1520g *vs.* 1805g and 1738g; P<.01). Presence of tannin reduced food intake and depressed metabolism, particularly in **MD**, affected the productive efficiency and the slaughtering traits. In the second trial productive performances of **MD** and **CD** fed C1 did not show the lack of growth but **CD** showed higher plasma glucose levels in the diet containing sorghum, probably also for the metionine addition. Higher traits of RCC were observed in **MD** fed with diet A1 and C1 than in birds fed with diet B1. Higher incidence of the breast muscles were observed in **MD** fed diet A1 than group fed diet C1.

Key words: duck, sorghum, metabolic profile, meat quality

Zusammenfassung

Titel der Arbeit: **Die Wirkung von Sorghum auf das Rumpfgewicht und die Fleischqualität von Enten**

Innerhalb eines Jahres wurden zwei Versuche durchgeführt um metabolische Wachstumsprofile und Schlachtkörpermerkmale von italienischen, männlichen Moschusenten **(MD)** und weiblichen Pekingenten **(CD)** zu untersuchen, denen sorghumhaltige Nahrung verabreicht wurde. Im ersten Versuch wurden die Enten vom Schlupf bis zur Schlachtung *ad libitum* mit drei experimentellen, isoenergetischen und isoproteinischen Diäten gefüttert: Diät A (auf Maisbasis), Diät B (50% Mais und 50% Tannin-Sorghum **(HTS)**), Diät C (auf HTS-Basis). Im zweiten Versuch wurden die Enten vom Schlupf bis zur Schlachtung *ad libitum* mit drei experimentellen, isoenergetischen Diäten gefüttert: Diät A1 (auf Maisbasis), Diät B1 (auf einer niedrigen Tannin-Sorghum-Basis (LTS), plus 1,5 g/kg Starter bzw. 2,5 g/kg Finisher von dl-Methionin), Diät C1 (50% LTS, 50% HTS plus 1,5 g/kg Starter bzw. 2,5 g/kg Finisher von dl-Methionin). Das individuelle Lebendgewicht und der Futterverbrauch wurden wöchentlich pro Käfig ermittelt. Blutproben wurden bei der Schlachtung entnommen. Die Moschusenten wurden im Alter von 11 Wochen geschlachtet und die Pekingenten im Alter von 8 Wochen.

Im ersten Versuch war das Lebendgewicht von mit der Diät C gefütterten Moschusenten und Pekingenten niedriger als das Lebendgewicht von den mit den anderen beiden Diäten gefütterten Tieren (Moschusenten: 2053 g vs.3537 g und 3000 g; Pekingenten: 1520 g vs. 1805 g und 1738 g; P<.01). Der Tanningehalt reduzierte die Nahrungsaufnahme und senkte den Metabolismus, vor allem bei Moschusenten. Er beeinträchtigte die Produktivität und die Schlachtleistungsmerkmale. Im zweiten Versuch zeigten die Produktionsleistungen von mit der Diät C1 gefütterten Moschusenten und Pekingenten keine Wachstumsmängel. Die Pekingenten hatten

* Research supported by National Research Council of Italy Special Project RAISA sub project n.3.

höhere Plasmaglukosewerte bei Verfütterung der sorghumhaltigen Diät, wobei wahrscheinlich auch die Zugabe von Methionin berücksichtigt werden muß. Bei Moschusenten, gefüttert mit den Diäten A1 und C1, wurden höhere RCC-Werte beobachtet als bei mit der Diät B1 gefütterten Vögeln. Moschusenten, die mit der Diät A1 gefüttert wurden, hatten ein höheres Brustmuskelgewicht als Tiere der mit der Diät C1 gefütterten Gruppe.

Schlüsselwörter: Enten, Sorghum, metabolische Profile, Fleischqualität

Introduction

Between cereals which growth during the hot season sorghum is one of the most resisting to fault of water. It can survive to dry periods and give good productions. For these reasons sorghum is one of the most important cereal in the Developing Countries, on account of its growing capacity in semi-arid areas which characterised the tropics and subtropics.

A great number of researchers (GUALTIERI and RAPACCINI, 1990; RIGONI et al., 1987; LUCBERT and CASTAING, 1986; ELKIN et al, 1978; ROSTAGNO et al., 1973) studied the nutritional features of many sorghum cultivars as a possible substitute for corn in poultry diets and ELKIN et al. (1990) provided some results on employment of sorghum in duck feeding but it is difficult to compare the results of the different feeding trials (GUALTIERI and RAPACCINI, 1990) on account of the variability of the chemical composition of the various cultivars. However the use of the sorghum must be limited on account of the anti-nutritional effects related to its tannin content. In these last years new low tannin sorghum lines have been selected and new hybrids produced. These new hybrids give similar results to corn in poultry feeding, sorghum in fact is the most similar cereal to corn when tannins are removed.

Italian strains of ducks give lower performances than ducks bred in other countries. These ducks have not been submitted to specific genetic programs for the improving of their performances but are characterised by a reduced fat content and by a good rusticity (PACI et al., 1992, 1993). For these reasons the purpose of present study was to evaluate the effect of diets containing sorghum on growth performance, metabolic profiles and carcass traits of the Italian ducks (Muscovy ducks males and Common ducks females).

Material and Methods

Two experiments were carried out during one year: 136 Muscovy ducks males (**MD**) and 212 Common ducks females (**CD**) were used in the first trial and 132 Muscovy ducks males and 225 Common ducks females were used in the second trial. All ducks belonged to local strains, not selected for growth speed. The ducklings of each experiment, randomly chosen, were bred in 18 different pens, inside a window-less poultry house from one to 28 days old (day-light: 23L:1D). At the age of 29 days the birds were transferred to open air pens. The density in each pen was 3 males/m^2 or 5 females/m^2.

In the first trial ducks were fed *ad libitum* three experimental isoenergetic and isoproteic pelletted diets. The principal cereal components were: corn (diet A), corn

Table 1
Diet composition used in the trials (Rationszusammensetzung in den Versuchen)

FIRST TRIAL		STARTER PERIOD (1-42 days)			FINISHER PERIOD (43 days-slaughtering)		
Ingredients		Diet A	Diet B	Diet C	Diet A	Diet B	Diet C
Corn, yellow grain	%	69.00	36.50	---	75.00	41.00	---
Soybean meal (44%)	%	26.00	23.50	18.5	20.00	16.00	13.00
High-tannin Sorghum	%	---	34.00	74.00	---	36.00	78.00
Dicalcium phosphate	%	1.50	1.50	1.50	1.50	1.50	1.50
Calcium carbonate	%	1.00	1.00	1.00	1.00	1.00	1.00
Sodium chloride	%	.15	.15	.15	.30	.30	.30
DL-metionine	%	.35	.35	.35	.10	.10	.10
Lysine	%	---	---	---	.10	.10	.10
Premix*	%	1.00	1.00	1.00	1.00	1.00	1.00
Vegetable oil	%	1.00	2.00	3.5	1.00	3.00	5.00
Calculated analysis							
Metabolizable energy	MJ/kg	12.52	12.23	12.05	12.81	12.77	12.57
Protein	%	17.93	18.39	18.18	15.57	15.50	16.04
Fat	%	3.54	4.20	5.35	3.72	5.36	6.91
Fibre	%	3.82	3.93	3.96	3.58	3.61	3.72
Ash	%	5.72	5.76	5.71	5.70	5.67	5.71

SECOND TRIAL		STARTER PERIOD (1-42 days)			FINISHER PERIOD (43 days-slaughtering)		
Ingredients		Diet A1	Diet B1	Diet C1	Diet A1	Diet B1	Diet C1
Corn, yellow grain	%	70.00	---	---	75.50	---	---
Soybean meal (44%)	%	26.00	24.00	22.00	20.00	18.00	16.00
High-tannin Sorghum	%	---	---	36.00	---	---	37.40
Low-tannin Sorghum	%	---	69.90	35.70	---	75.00	38.20
Dicalcium phosphate	%	1.50	1.50	1.50	1.50	1.50	1.50
Calcium carbonate	%	1.00	1.00	1.00	1.10	1.00	1.00
Sodium chloride	%	.15	.10	.15	.30	.30	.30
DL-metionine	%	.35	.50	.65	.10	.35	.50
Lysine	%	---	---	---	.10	.10	.10
Premix*	%	1.00	1.00	1.00	1.40	1.25	2.00
Vegetable oil	%	---	2.00	2.00	---	2.50	3.00
Calculated analysis							
Metabolizable energy	MJ/kg	12.30	12.21	11.94	12.51	12.63	12.35
Protein	%	18.02	17.96	18.32	15.72	15.87	16.06
Fat	%	2.58	4.16	4.11	2.74	4.81	5.18
Fibre	%	3.85	3.41	3.60	3.59	3.14	3.29
Ash	%	5.73	6.41	6.48	5.90	5.56	6.84

*Per kilogram of diet: vitamin A 8,000 IU; cholecalciferol 2,000 IU; vitamin B1 1.5 mg; riboflavin 3 mg; vitamin B6 1.5 mg; vitamin B12 15µg; D-α-tocopherol acetate 7.5 IU; menadione sodium bisulfite 1.5 mg; niacin 25 mg; D-pantothenic acid 8 mg; choline chloride 500 mg; Co 0.2 mg; Fe 30 mg; I 1.4 mg; Mn 80 mg; Cu 1.5 mg; Zn 30 mg

and high tannin sorghum (diet B), and high tannin sorghum (diet C). In the second trial the ducks were fed *ad libitum* three isoenergetic experimental pelletted diets. The principal cereal components were: corn (diet A1), low tannin sorghum plus (1.5 g/Kg starter or 2.5 g/Kg finisher) dl-metionine (diet B1), and 50% low tannin sorghum with 50% high tannin sorghum plus (1.5 g/Kg starter or 1.5 g/Kg finisher) dl-metionine

(diet C1). The diet composition of the experimental diets are shown in Table 1, and the chemical composition of the two sorghum hybrids are shown in Table 2.

In both trials individual live weights and feed consumption per pen were recorded weekly. At slaughter age (11 weeks for **MD** and 8 weeks for **CD**), 8 ducks from each group were randomly chosen for plasma (Li-eparine) drawing. Every duck used for blood sampling and 7 ducks, randomly chosen in the same pen from each group, were slaughtered.

Table 2

Chemical composition (a.f.b.) of low tannin sorghum (LTS) and high tannin sorghum (HTS) (Chemische Zusammensetzung von Sorghum mit unterschiedlichen Tanningehalten)

		Corn	Sorghum	
			LTS	HTS
Crude protein	%	8.35	9.78	13.20
Ether extract	%	3.62	2.93	2.42
Crude fibre	%	2.88	1.81	3.62
Ash	%	1.18	1.20	2.01
N-free extract	%	71.95	72.27	66.73
Starch[1]	%	64.15	66.30	53.80
Total reducing substances[2]	%	1.40	2.00	.25
Total tannins[3]	%	---	.11	.89

(1) EEC method (polarimeter); (2) EEC method (expressed like glucose equivalent); (3) EEC method (expressed as percentage catechin equivalents)

Glucose, cholesterol, triglycerides, free fatty acids, uric acid, total protein, and albumine were analysed within 1-6 hours from drawing (BAGLIACCA et al., 1996).

The following slaughtering traits were weighed in the ducks immediately after electrical stunning (200 V per 5"), bleeding and dry-plucking: neck with head, giblets, gizzard, liver, ready to cook carcass, and abdominal fat. On ready to cook carcasses after 24h chilling (4°±.5°C) were weighed the following parameters: legs, skin with subcutaneous fat and breast muscles. The water holding capacity (GRAU and HAMM, 1957) and the thawing loss (meat frozen at -30°C, stored at -18°C, then thawed for 24 h at 4±.5°C) were determined on 5 breast muscles and 10 left legs per group. Data of thawing loss on breast muscles were lost in the first trial. On 6 right legs per group the muscle to bone/ratio was determined (by hand separation after bag boiling for 2.5 hours at a water temperature of 80°C).

In both trials data were analysed by two way analysis of variance to test the effect of the different category of ducks and diets. The continuous covariant (live weight or ready to cook carcass) was added to the model to analyse the slaughtering traits and every percentage was calculated on estimated means (WILKINSON, 1988).

Results and Discussion

Live weights, feed intake and feed conversion ratios of the **MD** and **CD** fed with the different diets in the two experiments are shown in Table 3.

In the first trial, live weights of **MD** fed with diet A were obviously significant higher than live weights of birds fed with the other two diets; between these last two groups, the group fed with the diet containing corn and **HTS**, showed better live weights than

the group fed with the diet in which **HTS** completely replaced corn (3537 g *vs.* 3000 g, and 2053 g, respectively, P<.01). The lowest live weights, the lowest feed intake and the highest feed conversion ratio performed with diet C. In the second trial the performances of the ducks did not show significant differences in relationship to the diets containing corn- (diet A1), **LTS-** (diet B1), and **LTS-** with **HTS-** (diet C1). This can be explained by the fact that synthetic metionine was added to the sorghum based diets (in addition to fat), to reduce the negative effects of tannin on the protein availability.

Table 3

Productive performances of Muscovy (1-77 days) and Common ducks (1-56 days) (Produktionsleistungen von Moschus- und Pekingenten)

	Muscovy duck males						Common duck females					
	diet A (n.45)		**diet B** (n.46)		**diet C** (n.45)		**diet A** (n.68)		**diet B** (n.71)		**diet C** (n.70)	
	avg	s.dev.	avg	s.dev.	avg	s.dev.	avg	s.dev.	avg	s.dev.	avg	s.dev.
Live weight (g)	3537**A**	312	3000**B**	423	2053**C**	307	1805**A**	163	1738**A**	271	1520**B**	177
Feed intake (g/day)	136**a**	2.2	127**ab**	3.5	111**b**	3.9	98	5.6	84	7.8	82	5.7
Feed conv. ratio	3.0**B**	.20	3.3**B**	.09	4.2**A**	.26	3.2	.10	3.3	.08	3.4	.18

	Muscovy duck males						Common duck females					
	diet A1 (n.44)		**diet B1** (n.45)		**diet C1** (n.43)		**diet A1** (n.75)		**diet B1** (n.75)		**diet C1** (n.75)	
	avg	s.dev.	avg	s.dev.	avg	s.dev.	avg	s.dev.	avg	s.dev.	avg	s.dev.
Live weight (g)	3453	225	3414	284	3354	237	1962**B**	194	1976**AB**	198	2076**A**	186
Feed intake (g/day)	152	9.06	149	3.92	148	6.39	125	4.3	121	3.0	121	9.5
Feed conv. ratio	3.5	.15	3.4	.09	3.5	.15	3.7	.06	3.5	.02	3.3	.32

note: means with different letter are significantly different (capital letters p<.01, cursive letters p<.05)

Regarding **CD**, in the first experiment, birds fed with diet A and diet B showed live weights similar but significantly higher than live weights of group fed with diet C (1805 g and 1738 g *vs.* 1520g; P<.01). No significant difference was observed in feed intake and feed conversion ratio between groups.

In the second trial the tendency to negative effects related to sorghum were completely removed, so that the diet C1 showed the best growth rate.

The slaughtering traits of **MD** and **CD**, observed in both experiments in relationship to the different diets, are reported in Table 4.

Regarding **MD**, in the first trial, even if the ready-cook-carcasses did not show significant differences between groups, the ducks fed with diet C provided the lowest yield (59.7% *vs.* 61.9% and 62.2%). The breast muscles incidence was significantly

Table 4
Slaughtering traits and meat characteristics (77 days old Muscovy and 56 days old Common ducks) (Schlachtkörperzusammensetzung und Fleischqualität von Moschusenten (77 Tage alt) und Pekingenten (56 Tage alt))

		Muscovy duck males						Common duck females					
		diet A		diet B		diet C		diet A		diet B		diet C	
		avg	s.dev.	avg	s.dev.	avg	s.dev.	avg	s.dev.	avg	s.dev.	avg	s.dev.
Live weight	g	3683A	138	3433B	126.4	2569C	215.7	1806A	61.8	1807A	78.5	1521B	85.3
Ready to cook Carcass	%lw	62.2	1.39	61.9	1.73	59.7	2.12	56.5	2.37	55.9	1.78	55.1	2.16
Abdominal fat	%lw	1.9	.37	1.9	.64	1.7	.61	2.2b	.57	2.1b	.50	3.3a	.65
Skin with subcutaneous fat	%rcc	18.9AB	1.22	17.3B	1.78	21.2A	1.72	27.7B	2.92	26.6B	3.21	31.9A	2.08
Breast muscles	%rcc	17.2A	1.22	17.8A	1.83	13.5B	1.43	11.2A	1.46	11.9A	2.74	7.4B	1.34
Left leg	%rcc	10.7	.59	10.2	.83	10.3	.64	10.9	.70	10.5	.80	9.5	.76
B.m.: dry matter	%	22.1a	.77	21.8a	.86	20.3b	.37	21.0	.70	21.0	1.30	20.3	.52
B.m.: thawing loss	%	---		---		---		---		---		---	
B.m.:WHC [1]		.42a	.024	.38a	.048	.27b	.029	.38	.025	.33	.063	.31	.028
Leg: meat/bone		4.7	.80	4.8	.77	5.1	.53	5.5	.57	5.2	.61	5.2	.39
Leg: thawing loss	%	3.1b	1.23	3.5b	1.90	7.0a	2.39	2.5	.82	2.3	1.05	3.2	1.24

		Muscovy duck males						Common duck females					
		diet A1		diet B1		diet C1		diet A1		diet B1		diet C1	
		avg	s.dev.	avg	s.dev.	avg	s.dev.	avg	s.dev.	avg	s.dev.	avg	s.dev.
Live weight	g	3460	176.2	3430	156.6	3358	176.1	1889	153.1	1893	145.9	1966	158.8
Ready to cook Carcass	%lw	62.9a	1.29	61.8b	1.29	62.8a	.87	57.0	1.77	58.1	1.70	58.2	1.56
Abdominal fat	%lw	1.0	.31	1.2	.30	1.3	.31	1.1b	.35	1.4ab	.46	1.5a	.52
Skin with subcutaneous fat	%rcc	16.4	1.99	17.1	1.76	17.0	1.89	25.7	2.50	26.5	3.24	26.4	3.24
Breast muscles	%rcc	19.4a	1.32	18.1ab	1.73	17.8b	1.47	15.5	1.76	15.1	1.07	16.1	1.53
Left leg	%rcc	10.4	.39	10.3	.45	10.5	.97	9.6A	.60	9.2AB	.71	8.7B	.67
B.m.: dry matter	%	22.5	1.38	23.1	1.49	23.9	1.98	22.0	.93	22.9	1.32	22.7	1.72
B.m.: thawing loss	%	12.2	4.10	9.7	2.61	8.9	3.34	13.1	2.49	14.3	4.34	17.2	7.30
B.m.:WHC [1]		.49	.021	.46	.019	.47	.020	.47	.020	.45	.020	.51	.020
Leg: meat/bone		4.8b	.41	4.8b	.22	5.4a	.38	5.7	.53	5.9	.61	5.7	.63
Leg: thawing loss	%	1.8B	.53	2.40AB	.65	2.60A	.94	2.7b	1.00	4.1a	.78	3.7ab	1.98

note: means with different letter are significantly different (capital letters p<.01, cursive letters p<.05); (1) WHC = water holding capacity

Table 5
Haematic parameters of Muscovy and Common ducks fed different diets (Blutparameter von mit verschiedenen Diäten gefütterten Moschus- und Pekingenten)

HAEMATIC PARAMETERS		Muscovy duck males						Common duck females					
		diet A		diet B		diet C		diet A		diet B		diet C	
		avg	s.dev.	avg	s.dev.	avg	s.dev.	avg	s.dev.	avg	s.dev.	avg	s.dev.
Glucose	mmol/l	10.9A	.86	10.9A	.77	9.1B	1.16	11.0	2.27	12.4	1.29	10.5	1.84
Cholesterol	mmol/l	2.9b	.33	3.3ab	.35	3.7a	.38	4.1b	.69	4.5b	.56	5.6a	.49
Triglycerides	mmol/l	1.4ab	.39	1.3b	.31	2.0a	.30	2.6b	1.64	1.4b	.30	4.4a	1.98
NEFA	µEq/l	246b	43	277ab	127	434a	76	658	144	486	151	590	163
Uric Acid	µmol/l	180	33	197	94	280	69	386	83	329	90	294	67
Total protein	g/l	41.2	2.89	38.4	3.49	39.1	4.65	35.3	3.82	34.7	1.71	34.9	2.70
Albumine	µmol/l	214	22.6	207	30.9	182	26.0	172	20.2	190	22.9	152	24.1

HAEMATIC PARAMETERS		Muscovy duck males						Common duck females					
		diet A1		diet B1		diet C1		diet A1		diet B1		diet C1	
		avg	s.dev.	avg	s.dev.	avg	s.dev.	avg	s.dev.	avg	s.dev.	avg	s.dev.
Glucose	mmol/l	11.5a	.59	11.3ab	1.55	11.0b	.63	9.1b	.66	9.5a	.48	9.9a	.83
Cholesterol	mmol/l	4.1a	.67	3.4b	.46	4.0a	.81	5.1	.82	4.9	.57	4.9	.59
Triglycerides	mmol/l	1.7	.64	1.9	.63	1.6	.50	1.8b	.58	2.6a	.77	2.0b	.56
NEFA	µEq/l	515a	61	465b	72	496ab	125	843b	234	994a	227	647c	167
Uric Acid	µmol/l	184	58	198	44	192	82	312	119	332	128	309	100
Total protein	g/l	36.8	3.41	37.2	4.67	36.5	5.30	48.5a	4.81	46.6ab	5.98	44.1b	4.04
Albumine	µmol/l	192	40	189	26	196	26	178b	18	192a	18	182ab	26

note: means with different letter are significantly different ($p<.05$)

lower in the ducks fed with diet C than in the others two groups (13.5% *vs.* 17.2% and 17.8%, P<.01). Higher proportion of skin with subcutaneous fat resulted in slaughtered ducks fed with diet C but differed significantly only from the ducks fed the diet B (21.2% *vs.* 17.3%, P<.01). In the second trial, even if the incidence of the ready to cook carcasses showed very closed values between groups, significative differences of ready to cook carcasses resulted in ducks fed with diet A1 and C1 in respect to ducks fed with diet B1 (62.9% and 62.8% *vs.* 61.8%, respectively; P<.05). Even if the carcasses obtained by the ducks fed the diet C1 were not lighter compared to control, a general tendency to higher incidence of skin and lower incidence of breast muscles was observed; the decreased breast muscle yields were statistically significative between control and C1 (A1=19.4% and C1=17.8%, P<.05). In the first trial, the water retention of meat showed a decrease in relationship to the tannin content, in fact the water holding capacity of the breast muscles and the thawing loss of the left leg differed between diet C *vs.* diet A and B. In the second trial the effect of the diets on the water retention was conditioned by the water content of the meat (measured in the breast muscles) which was lower in diet C1 than B1 and A1. For this reason the water holding capacity and the thawing loss of the breast muscles did not show any negative tendency but only the thawing loss of the leg increased with the tannin content (diet C1 high significantly differed from diet A1).

The data related to the effect of the different diets on the slaughtering traits of **CD** showed that breast muscles proportion was significantly lower (P<.01) in ducks fed diet C (7.4%) than diets A and B (11.2% and 11.9%). On the contrary, the skin with subcutaneous fat and the abdominal fat were higher in the carcasses bearing to the group fed diet C than the group fed diet A and B (skin with subcutaneous fat: 34.9% *vs.* 27.7% and 26.6%, P<.01; abdominal fat: 3.3% *vs.* 2.2% and 2.1%, P<.05). In the second trial the introduction of sorghum in the diet did not determine any lack of the slaughtering traits but a tendency to higher of ready to cook yields and abdominal fat contents were observed in C1; the abdominal fat to live weight ratio was significantly higher in diet C1 than in diet A1 (1.5% *vs.* 1.1%, P<.05). Also the incidence of breast muscles to ready to cook ratio showed a tendency to increase in C1, so that the incidence of the leg to ready to cook ratio was significantly lower in C1 than A1 (8.7% *vs.* 9.6%, P<.01). In the first and in the 2nd trial, the water retention of meat showed a tendency to worsening in relationship to the tannin content of the diets; however no difference was observed in the first trial between the water holding capacity and the thawing loss while in the second trial the thawing loss of the left leg was significantly lower in controls than in diet B1 (the average thawing loss of the C1 did not reach the minimum significative difference from controls).

The serum levels of the different metabolites (estimate means ± standard deviation), measured at the slaughtering ages, are shown in Table 5.

In Muscovy ducks results showed that glucose was lower while cholesterol, triglycerides, free fatty acids, and uric acid levels, were higher in ducks fed the diets containing **HTS**. The fat added to the diet was probably the cause of the increase of the parameters of fat metabolism and the reduction of feed intake was probably the cause

of the decrease of the presence of sugar in plasma; the plasma increase of uric acids (even if not statistically significant) is not clear but cannot be related to the increase of protein availability. In the second trial the differences between metabolic profiles were reduced but the tendency to the decrease of glucose and the increase of the parameters of fat metabolism remained.

In the first trial, the data related to the effect of the different diets on the metabolic profiles of **CD** showed that cholesterol and tryglicerides were significantly higher in the diet containing **HTS** but no difference was observed between the diets regarding to plasma glucose. In the second trial the glucose level was not lower, but significantly higher, in the diets containing sorghum. This fact confirmed the results already shown by the productive performances with better growth in **CD** fed the sorghum diets.

The trial carried out make an experimental contribution to the knowledge of the effects of sorghum on productive performances and slaughtering traits of ducks. As regards the productive performances the results confirmed the equivalent nutritive value of corn or low tannin sorghum when supplemented with fat and synthetic aminoacids.

High concentrations of tannin reduce food intake, particularly in **MD**, and depresses the metabolism with the consequence of a lack of growth in both species, according to what already observed by CHANG and FULLER (1964), ROSTAGNO et al. (1973), and ARMSTRONG et al. (1974) in chicks. Leg abnormalities characterised by an outward bowing of the leg, whose aetiology was investigated by ELKIN et al. (1978), appeared also in four duck of our first experiment. The dietary addition of dl-metionine seems to be able minimise the effect of tannins so that in the second trial **CD** improve metabolism and productive efficiency.

The results showed that sorghum based diets may not affect the fresh meat quality characteristic but seem to modify the quality parameters of meat submitted to physical treatments (deep freezed then thawed). Consequently the quality of the carcasses, freezed or deep freezed for conservation, can be worsened when ducks are fed sorghum based diets.

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Received: 11.10.1996

Accepted: 10.04.1997

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