Use of sorghum in broiler chicken diets: effects on performance, carcass parameters, meat quality and intestinal health

Gheorghe Anca
Hăbeanu Mihaela
Ghiță Elena

National Research-Development Institute for Animal Biology and Nutrition Balotesti,
Calea Bucuresti no. 1, 077015 Balotesti, Romania

CONTEXT

- In the curent context of climate change, it is expected that the heat resistant crops such as sorghum are routinely used as food and feed resources for humans and animals (Selle et al., 2010; García et al., 2013).
- Sorghum is an interesting alternative energy ingredient in poultry diets due to its similar nutritional composition to corn (Leeson and Summers, 2005). Despite higher protein content of sorghum, the digestibility of some essential amino acids, such as lysine, methionine, and threonine, is relatively lower than those of corn (Rostagno et al., 2011).
- The use of new varieties of sorghum (low-tannin) in broiler diets as partial or total corn substitute have been associated with inconsistent, and even sub-optimal growth performance of broiler chickens.

OBJECTIVE

The study evaluate the effects of **dietary sorghum (var. *Albanus*) inclusion as partial substitute (50%) of corn** on performance, carcass parameters, meat quality and intestinal health in broilers.

MATERIAL AND METHODS

Experimental design

400 broilers (Cobb 500 hybrid) were divided in 2 groups (4 replicate/group) and used in a 35d feeding trial.

- Broilers were fed corn-soybean meal control diet (C) or corn-sorghum-soybean meal diet (S).
  - The diets were isocaloric and isonitrogenous, with similar content of digestible sulphur amino acids, lysine, calcium and available phosphorus (Cobb-Vantress, 2015).
  - Broilers were housed in an environmentally controlled house, in pens with wood shavings.
  - Feed (mash) and water were provided *ad libitum*.

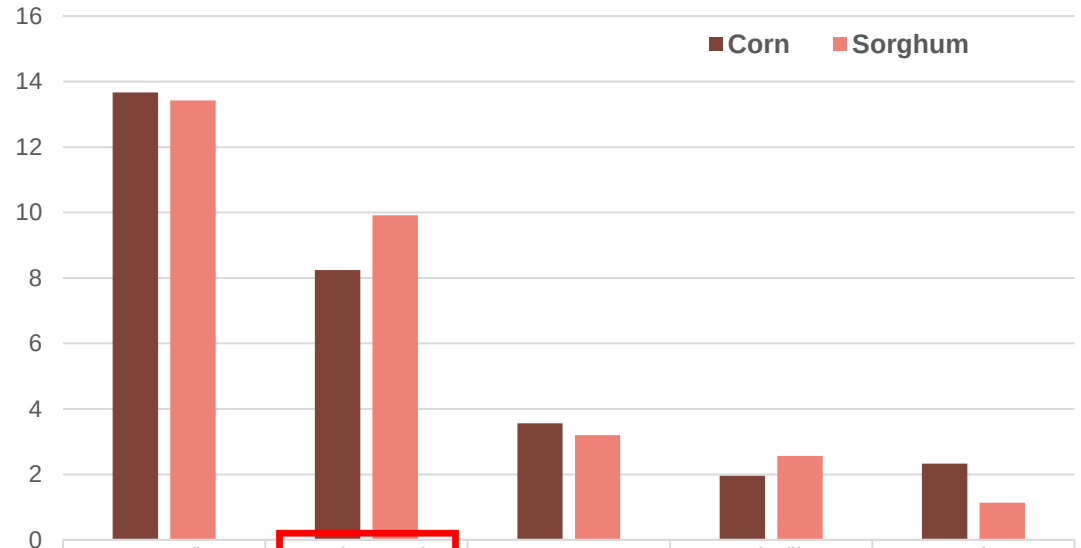
Control diet - C
(corn-soybean meal)

Sorghum diet - S
(corn-sorghum-soybean meal)

MATERIAL AND METHODS

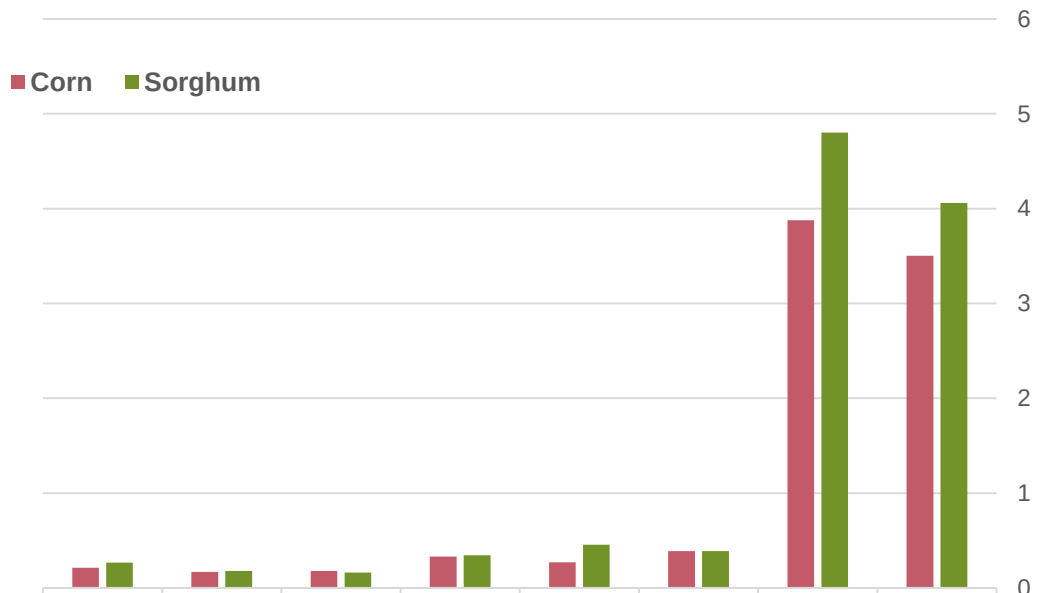
NUTRITIVE VALUE OF SORGHUM var. ALBANUS

Chemical composition



	ME, MJ/kg	Crude protein	Fat	Crude fiber	Ash
Corn	13,67	8,24	3,56	1,96	2,33
Sorghum	13,42	9,91	3,2	2,56	1,14

Amino acids profile



	Lys	Met	Cys	Met+Cys	Tre	Arg	EAA	NEAA
Corn	0,212	0,17	0,18	0,33	0,269	0,388	3,877	3,502
Sorghum	0,266	0,18	0,164	0,344	0,457	0,387	4,802	4,059

MATERIAL AND METHODS

DIETS

Ingredients (g/kg)	Starter (1-10 d)		Grower (11-22 d)		Finisher (23-35 d)	
	C	S	C	S	C	S
Corn	560.0	275.4	600.0	307.0	657.6	332.7
Sorghum var. *Albanus*	**-**	**275.4**	**-**	**307.0**	**-**	**332.7**
Soybean meal	310.0	300.0	269.0	250.0	220.0	210.0
Corn gluten meal	50.0	59.3	46.0	50.0	36.0	35.0
Sunflower oil	28.0	37.8	35.0	36.0	40.0	43.0
Monocalcium phosphate	18.2	17.9	17.0	16.2	15.0	14.6
Calcium carbonate	14.7	14.8	13.9	14.0	12.7	12.8
Salt	3.0	3.0	3.0	3.0	3.0	3.0
Vitamin-mineral premix	10.0	10.0	10.0	10.0	10.0	10.0
DL-methionine	1.5	1.5	2.0	2.3	1.9	2.1
L-lysine HCl	4.0	4.3	3.5	3.9	3.2	3.5
Choline HCl	0.6	0.6	0.6	0.6	0.6	0.6
Analysed composition g/kg						
Dry matter	890.3	891.0	891.8	886.7	883.5	885.9
Crude protein	219.9	220.6	202.5	201.3	180.0	181.0
Ether extract	43.7	44.1	52.9	51.8	61.6	61.8
Crude fiber	34.3	35.7	32.3	33.8	30.6	31.4
Ash	62.0	63.3	59.3	57.2	55.9	53.4
Calcium	9.1	9.1	8.5	8.5	7.7	7.7
Total phosphorus	6.8	6.8	6.3	6.3	6.0	6.0
ME (MJ/kg)	12.61	12.62	12.97	12.97	13.30	13.32

The diets were isocaloric and isoprotein, with similar content of digestible sulphur amino acids, lysine, calcium and available phosphorus (Cobb-Vantress, 2015).

MATERIAL AND METHODS

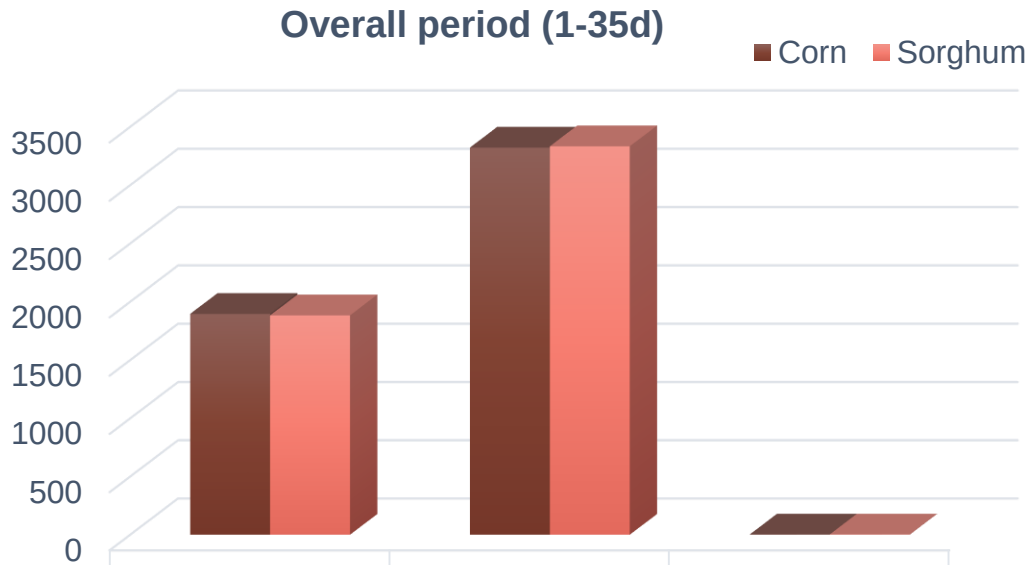
Sampling

- At the end of trial 16 broilers/treatment were slaughtered for:
  - carcass traits evaluation;
  - breast muscle (*Pectoralis major*) analysis;
  - ileal content analysis.

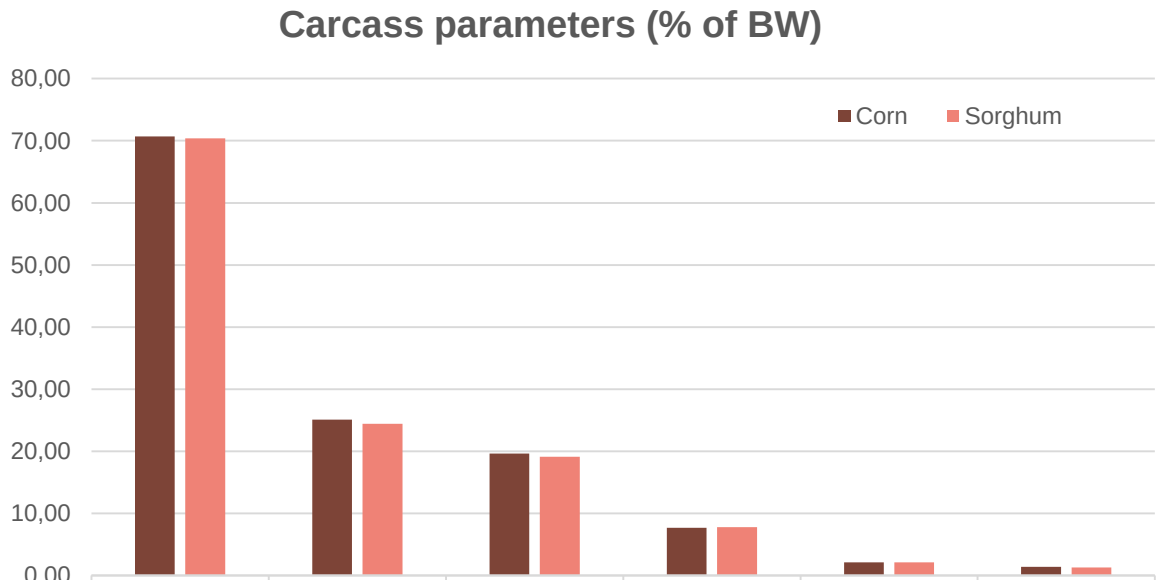
Chemical and microbiological analysis

- Standardized methods according to EU Regulation 152/2009 (OJEU, 2009) were used to determine the gross chemical composition of ingredients, diets and meat samples.
- Amino acids content were determined by high performance liquid chromatography (HPLC).
- Muscle pH was measured with a portable HACCP pH meter for meat.
- Ileal bacterial populations (*Enterobacteria, E. Coli*, *Lactobacillus* spp. and *Salmonella)* were determined on selected media using a colony counter.

PERFORMANCE



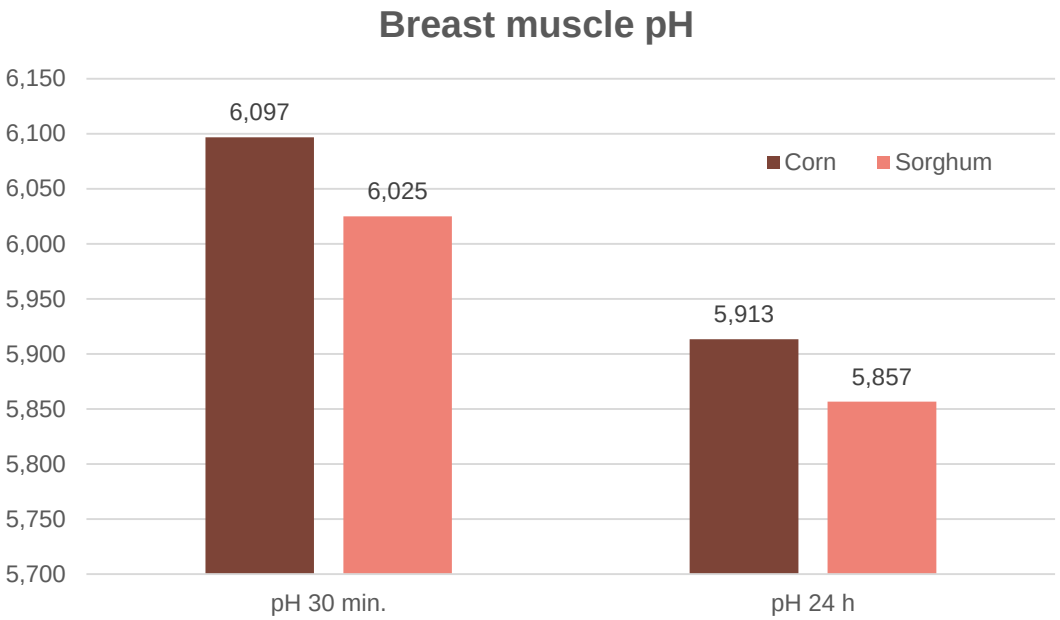
	BWG (g/bird)	FI (g/bird)	FCR (g feed:g gain)
Corn	1895,86	3321,91	1,75
Sorghum	1883,4	3332,81	1,77

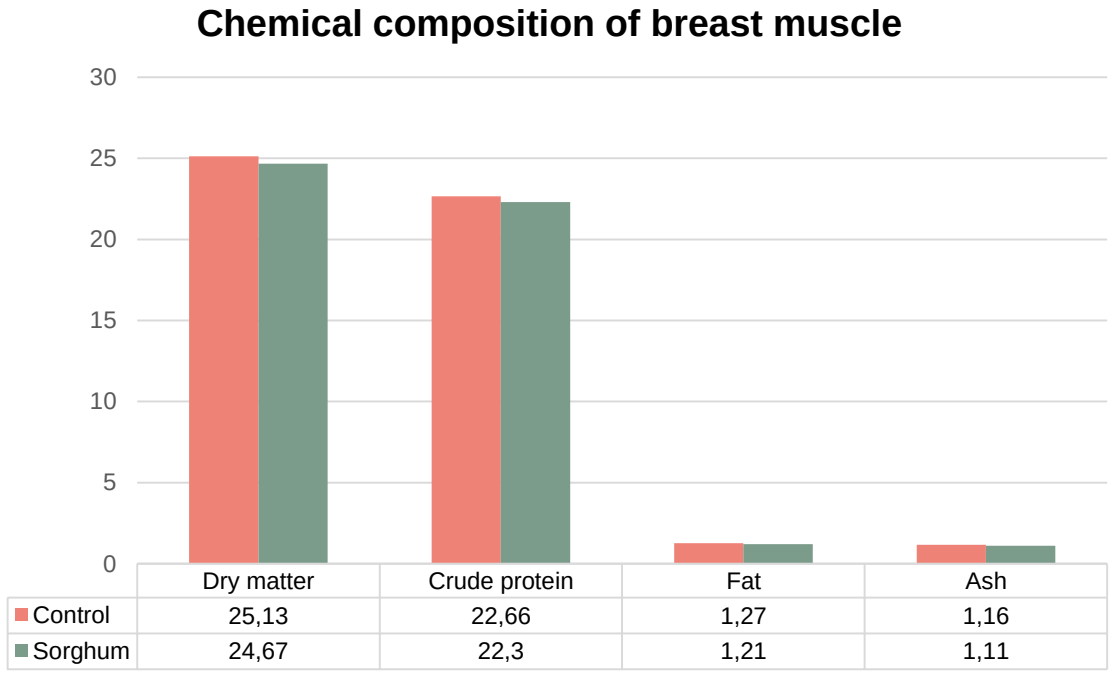


	Carcass yields	Breast	Leg	Wings	Liver	Abd. fat
Corn	70,71	25,10	19,61	7,65	2,12	1,37
Sorghum	70,40	24,39	19,11	7,79	2,11	1,27

Growth performance (body weight gain, feed intake and feed conversion ratio) or **carcass parameters** (carcass and cut-up parts yields) were not affected (P>0.05) by sorghum inclusion. Results were similar with previous studies (Torres et al., 2013; Garcia et al., 2013; Stringhini et al. 2009; Santos et al., 2006).

MEAT QUALITY





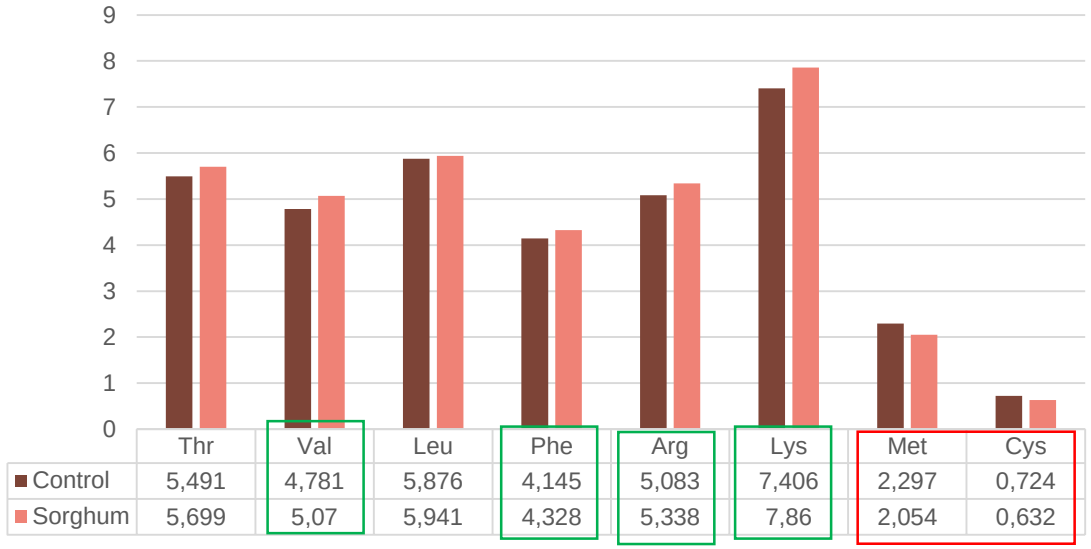
An important factor in chicken meat quality evaluation is pH. Functional properties of meat dependent on glycolytic reactions that occur during *rigor mortis*, affecting meat pH directly.

pH values of breast muscle were in the normal limits **5.7-6.1** (Fletcher et al. 2000) and was not affected (P>0.05) by dietary treatment.

There was no effect (P>0.05) of the dietary sorghum addition on **chemical composition** of breast muscle.

MEAT QUALITY

Essential amino acids of breast muscle

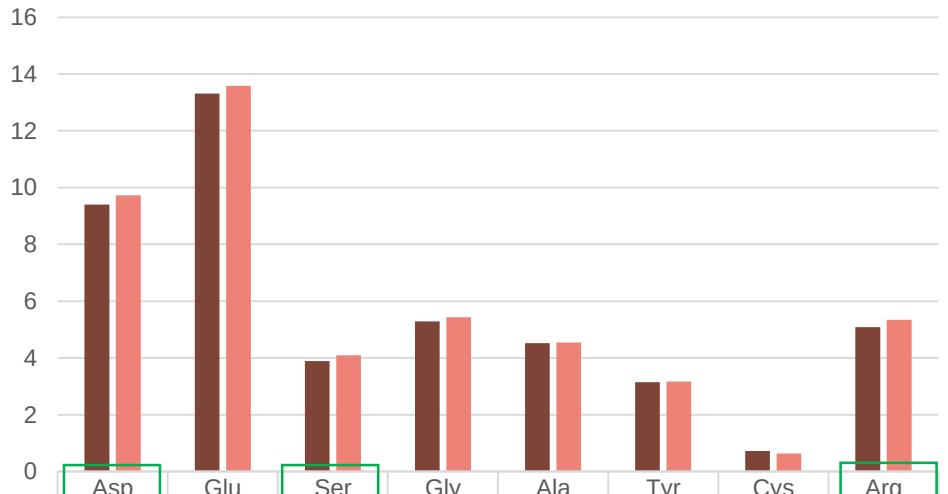


	Thr	Val	Leu	Phe	Arg	Lys	Met	Cys
Control	5,491	4,781	5,876	4,145	5,083	7,406	2,297	0,724
Sorghum	5,699	5,07	5,941	4,328	5,338	7,86	2,054	0,632

At level of individual EAA the breast muscle of S group had **higher contents of valine** (+6.04%; P=0.001), **phenylalanine** (+4.29%; P=0.03), **arginine** (+5.01%; P=0.001) and **lysine** (+6.13%; P=0.04) and **lower levels** of **sulphur amino acids**: methionine (-10.58%; P=0.001) and cysteine (-12.7%; P=0.003) *vs.* C group.

Glutamine is one of the **main aromatic amino acids that determine** the umami **taste of meat** (Yamaguchi, 1991). In addition to free glutamine, **free aromatic amino acids**, such as **phenylalanine and tyrosine**, also play an **important role in** enhancing **the savory or umami taste** at sub threshold concentrations in the presence of salt and free acidic amino acids (Lioe et al., 2005; Hoffman et al., 2005).

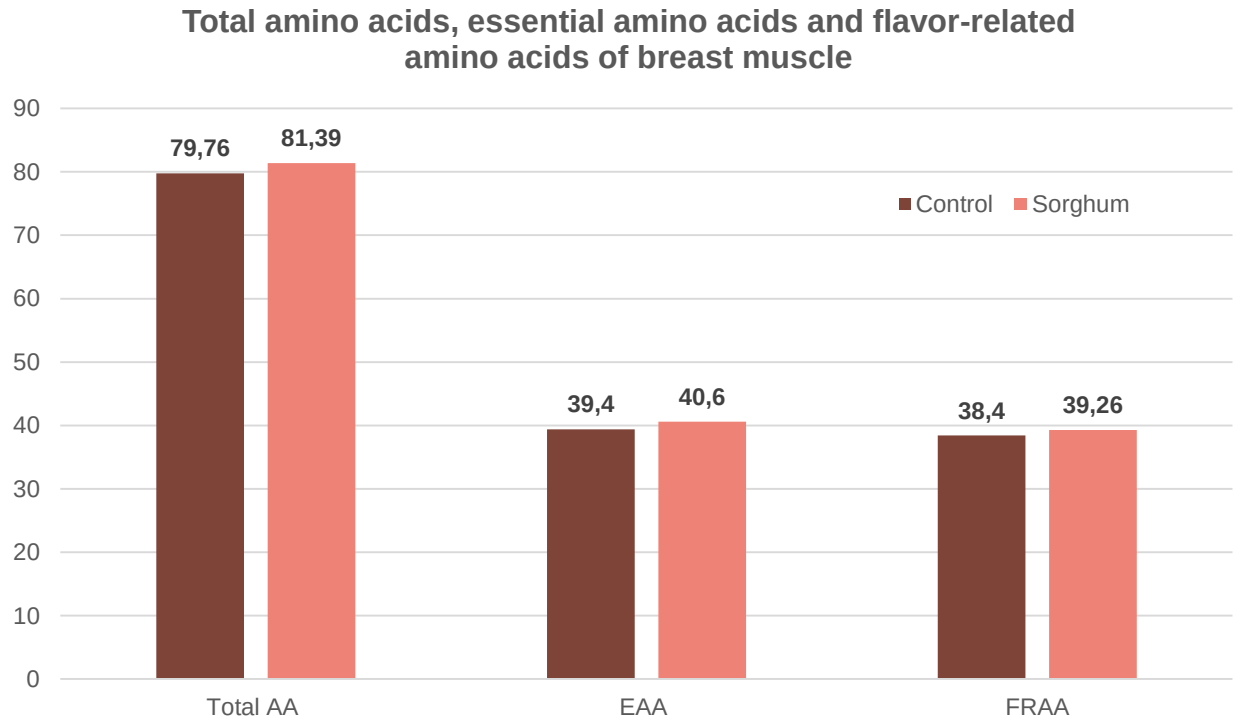
Flavor-related amino acids of breast muscle



	Asp	Glu	Ser	Gly	Ala	Tyr	Cys	Arg
Control	9,4	13,308	3,89	5,284	4,523	3,147	0,724	5,083
Sorghum	9,728	13,585	4,09	5,438	4,546	3,171	0,632	5,338

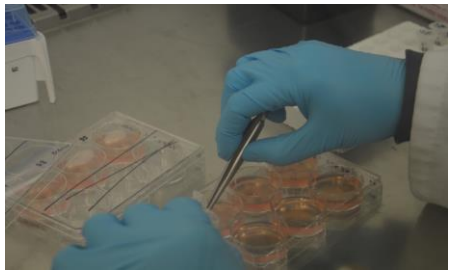
From FRAA the breast muscle of S group had higher contents of **aspartic acid** (+3.49%;P=0.007), **serine** (+5.14%; P=0.02) *vs.* C group.

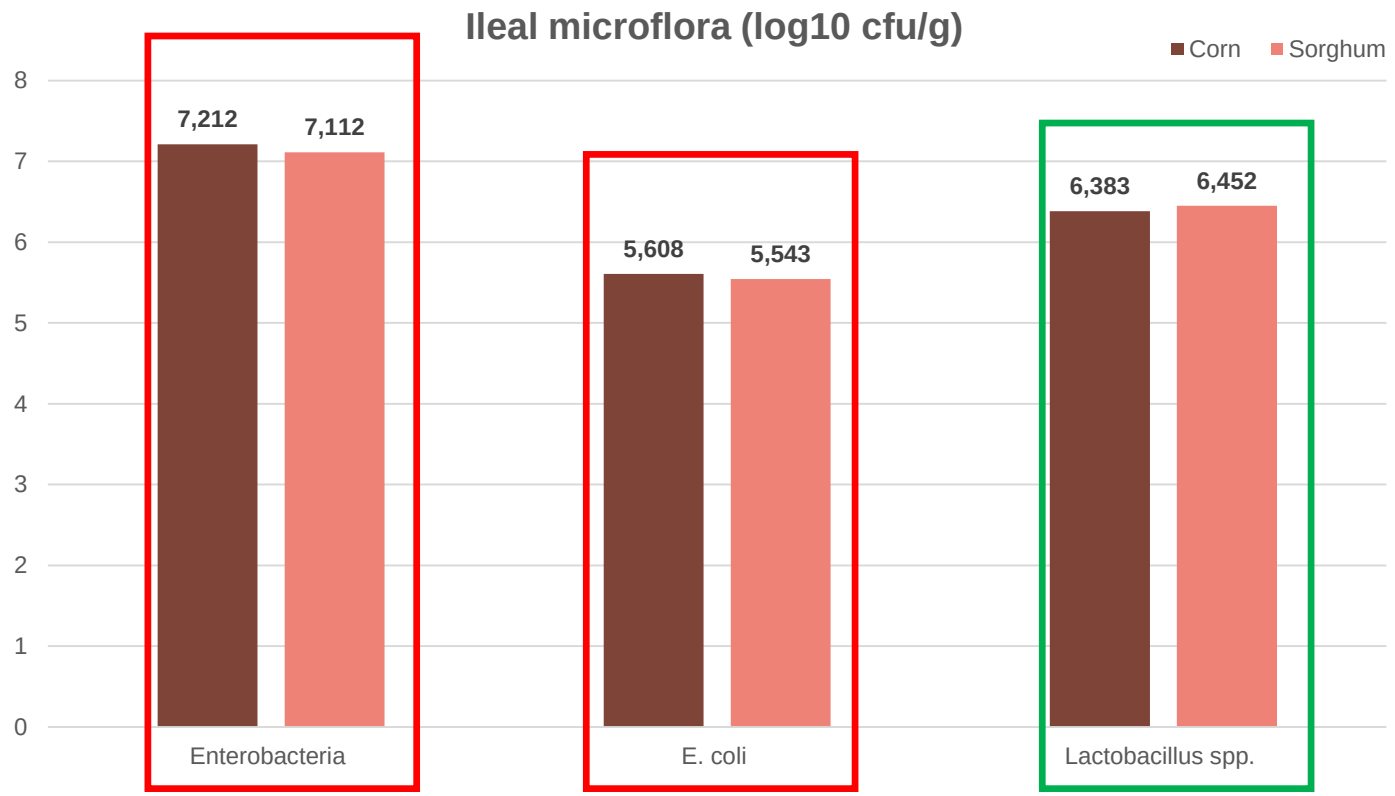
MEAT QUALITY



Although, at the level of some individual amino acids there was differences (P<0.05) between dietary treatments, the **total TAA content, essential amino acids (EAA) and flavour-related amino acids (FRAA) in breast muscle was not significantly influenced** (P>0.05) **by sorghum inclusion** as partial replacement of corn in broiler diets.

INTESTINAL HEALTH





Sorghum had a beneficial effect on intestinal health by increasing the ileal population of *Lactobacillus* spp. (+1.07%; P=0.01) and decreasing the *Enterobacteria* (-1.38%; P<0.0001) and *E. coli* (-1.16%; P=0.02).

CONCLUSION

The use of **sorghum (var. *Albanus*) as partial substitute of corn** in broiler diets:

- had no adverse effects on growth performance and carcass traits at slaughter age;
- archive similar chemical composition, nutrients and flavor of breast muscle as important meat quality parameters;
- improve the intestinal health status by increasing the beneficial bacterial population such us *Lactobacillus* spp.

Sorghum (var. Albanus) is suitable option for broiler diets as partial replacement for corn, especially in the current context of climate change, prices volatility and changes in availability of corn as major energy source in poultry feeding market.

Thank you for attention!