



HAL
open science

A meta-analysis on the potential utilization of millet, sorghum and cottonseed meal in broiler feeding

Dolores Batonon, Denis Bastianelli, Philippe Lescoat, G. M. Weber, Murtala
Umar-Faruk

► **To cite this version:**

Dolores Batonon, Denis Bastianelli, Philippe Lescoat, G. M. Weber, Murtala Umar-Faruk. A meta-analysis on the potential utilization of millet, sorghum and cottonseed meal in broiler feeding. 14. European Poultry conference, Jun 2014, Stavanger, Norway. hal-01189985

HAL Id: hal-01189985

<https://hal.science/hal-01189985>

Submitted on 1 Sep 2015

HAL is a multi-disciplinary open access archive for the deposit and dissemination of scientific research documents, whether they are published or not. The documents may come from teaching and research institutions in France or abroad, or from public or private research centers.

L'archive ouverte pluridisciplinaire **HAL**, est destinée au dépôt et à la diffusion de documents scientifiques de niveau recherche, publiés ou non, émanant des établissements d'enseignement et de recherche français ou étrangers, des laboratoires publics ou privés.

A meta-analysis on the potential utilization of millet, sorghum and cottonseed meal in broiler feeding

D. I. Batonon^{1,5}, D. Bastianelli², P. Lescoat³, G. Weber⁴, M. Umar Faruk⁵

¹INRA, UR83 Recherches Avicoles, F-37380 Nouzilly, ²CIRAD-SELMET, Systèmes d'élevage méditerranéens et tropicaux, Baillarguet TA C-112/A, F-34398 Montpellier, ³AgroParisTech, Département Sciences de la Vie et Santé - UFR Développement des Filières Animales, F-75231 Paris, ⁴DSM Nutritional Products Ltd, Nutrition Innovation Center, Basel, Switzerland, ⁵Research Centre for Animal Nutrition and Health, DSM Nutritional Products France, Saint Louis, France

Murtala.Umar-Faruk@dsm.com

Meta-analysis of alternative feed ingredients

Summary

A meta-analysis was performed to investigate bird's response on some selected alternative feed ingredients: millet, sorghum and cottonseed meal. The database used contained 186 treatments from 25 different experiments published from 1990 to 2013. A 1-way ANOVA was performed to determine the difference induced by each ingredient on average daily feed intake, body weight gain and feed conversion ratio, compared to control diets. Besides, mixed effects models were developed to test the impact of the level of substitution on all parameters during starter and growing phases. Results indicated an effect of the type of feed ingredient on feed intake and growth performance with better efficiency obtained in millet. No linear relationship was established between level of substitution and variables of interest for all ingredients ($R^2 \approx 0$). Additionally, the root mean square error (RMSE) determined for each subset of data demonstrated that observations of this study are practically predictable. Therefore, it is in perspective of this work to predict bird's response to those ingredients nutrients supply. This meta-analytic approach provides significant quantitative knowledge to utilize those ingredients at different levels without any detrimental effect in broilers. Regarding the anti-nutritional factors content of some of these ingredients, it would be interesting to further suggest improvements leading to an increasing utilization of these alternative feedstuffs in poultry.

Keywords: broiler, meta-analysis, millet, sorghum, cottonseed meal, performance

Introduction

As a consequence of the high development of poultry production, specifically in developing countries, there is an increasing demand for energy and protein sources for animal feeding. Several studies showed the interest of using millet (*Pennisetum glaucum*, *Setaria italica*, etc.) or sorghum (*Sorghum bicolor*) as alternative to maize, and cottonseed meal (*Gossypium* spp.) in replacement of soybean meal. However, conflicting results were reported in literature for cereals: reduced (Baurhoo et al., 2011) or similar performance (Torres et al., 2013), and for cottonseed meal (see review in Feedipedia, 2013). In order to get a general assessment of these ingredients, it is useful to interpret these studies together. Meta-analysis is a relevant method for summarizing and quantifying knowledge acquired through previously published research (Sauvant et al., 2008). Thus, the objective of this work was to investigate the qualitative and quantitative effect of the feed ingredients on broiler performance.

Materials and Methods

Description of the database

Articles investigating millet, sorghum and cottonseed meal inclusion in broiler diets from 1990 to 2013 were collected. A data set containing 171 treatments was extracted from 14 published papers (28 experiments), compiled, and subsequently entered into the meta-analysis process according to Sauvant *et al.*, 2008. Publications reporting several experiments were dealt with by assigning a specific code to each experiment. Each observation corresponded to the mean of one treatment group. Breeding phases were coded according to experimental periods mentioned in the publications. Thus, starter phase covered data collected from 0 to 21-d old while the growing phase ranged from 14 to 28-d of age.

Statistical analysis

Data analyses were performed using R version 3.0.2 (R Core Team, 2013)¹. Differences of experimental diets relative to the control (*Experimental – Control*) were calculated for average daily feed intake (ADFI) and body weight gain (BWG) in each experiment. Then, data were submitted to a 1-way ANOVA to determine whether millet and sorghum diets impacted ADFI, BWG and feed conversion ratio (FCR), compared to cottonseed meal-based diets. Results were considered significantly different if $P < 0.05$. A Bonferroni-Dunnet pairwise comparison was used to compare differences between means. However, another aim was to evaluate the effect of the level of substitution of the ingredient on the variables of interest. An experiment effect was introduced in the models in order to account factors like: bird line, physiological phases (starter vs. grower) and measurements methods. Thus, the models included this “experiment effect” as a random effect (Sauvant *et al.*, 2008) and relationships between Y (ADFI, BWG, FCR) and level of substitution (X) were analyzed with a mixed effects model as follows:

$$y_{ij} = \alpha + \alpha_i + \beta x_{ij} + \varepsilon_{ij}$$

Where y_{ij} is the measured variable for treatment j in the experiment i ; α is the overall intercept with fixed effect; α_i is the random effect for experiment i on the intercept α with the condition $\sum_{i=1}^N \alpha_i = 0$ (N is the number of experiments); β , the coefficient of for independent variable X and ε_{ij} the residual error.

Results and discussion

According to our models, broiler’s performance is affected by the type of ingredient (Table 1) and there is a hierarchy in feed conversion ratio with the best values obtained with millet followed by sorghum and cottonseed meal. Differences relative to control diet in each experiment revealed that birds offered millet-based diets reduced their consumption of 1.32% for starter phase and 3.18% for grower phase while increasing the weight gain of 0.33% and 2.37%, respectively from 1 to 21d and 14 to 28d. In contrast, in sorghum and cottonseed meal based diets, birds increased ADFI but had similar or reduced growth rate compared to control groups. Moreover, no linear relationship was established between level of substitution and variables of interest as shown in Tables 2 and 3. From 1 to 21d, null R^2 and lower RMSE were observed in all three ingredients with no significant P-value. This is in accordance with Goodarzzi-Boroojeni

¹R CORE TEAM (2013). R: A language and environment for statistical computing. R Foundation for Statistical Computing, Vienna, Austria.
URL <http://www.R-project.org/>.

et al., 2011. During grower phase, a trend was noted between ADFI and level of substitution for millet and sorghum while significant effect of level of substitution was observed for BWG. This could be related to results obtained by Hidalgo et al., 2004 and Baurhoo et al., 2011 who showed a significant effect of the level of substitution on ADFI and BWG. For further analysis, it could be suggested to subject observations to a weighing scheme to overcome this wide range of standard deviation (Sauvant et al., 2008).

This meta-analytic approach provides significant quantitative knowledge to utilize those ingredients at different levels without any detrimental effect in broilers. Though, it should be noted there were several varieties of sorghum or millet, which could be rich in anti-nutritional factors and influence their nutritional value and affect performance (Sharif et al., 2012). Thus, it is in the perspective of this work to (i) validate the model in vivo, (ii) to evaluate the possible interactions resulted from simultaneous utilization of these ingredients (iii) to assess the effects of nutrients supply on broiler's response within experiment and to further suggest improvements leading to an increasing utilization of these alternative feedstuffs in poultry.

References

- BAURHOO N., BAURHOO B., MUSTAFA, A. F. and ZHAO X. (2011) Comparison of corn-based and Canadian pearl millet-based diets on performance, digestibility, villus morphology, and digestive microbial populations in broiler chickens. *Poultry Science*, 90:579-586.
- HEUZE V., TRAN G., BASTIANELLI D., HASSOUN P. and LEBAS F. (2013) *Cottonseed meal*. Feedipedia.org. A program by INRA, CIRAD, AFZ and FAO. <http://www.feedipedia.org/node/550> [accessed 2014/03/12]
- GOODARZI BOROOJENI F., SAMIE A. H., EDRISS M. A., KHORVASH M., SADEGHI G., VAN KESSEL A., and ZENTEK J. Replacement of corn in the diet of broiler chickens using foxtail millet produced by 2 different cultivation strategies. *Poultry Science*, 90:2817–2827.
- HIDALGO M. A., DAVIS A. J., DALE N. M. and DOZIER, III W. A. Use of Whole Pearl Millet in Broiler Diets (2004) *Journal of Applied Poultry Research*, 13:229–234
- SHARIF M., IDREES M., TAUQIR N.A., SHAHZAD M.A., KHALID M.F., NISA M., SARWAR M. and KHAN M.L. (2012) Effect of water treatment of sorghum on the performance of broiler chicks. *South Africa Journal of Animal Science*, 42(2):189-194.
- SAUVANT D., SCHMIDELY, P., DAUDIN J. J. and ST-PIERRE, N. R. (2008) Meta-analyses of experimental data in animal nutrition. *Animal*, 2(8): 1203-1214.
- TORRES K. A. A., PIZAURO JR., J. M., SOARES C. P., SILVA T. G. A., NOGUEIRA W. C. L., CAMPOS D. M. B., FURLAN R. L. and MACARI M. (2013) Effects of corn replacement by sorghum in broiler diets on performance and intestinal mucosa integrity. *Poultry Science*, 92:1564–1571.

Table 1. Effects of millet, sorghum and cottonseed meal based diets on difference in ADFI, BWG relative to control and on FCR real values

	No of experiments	Difference in ADFI (g/b/d)		Difference in BWG (g/b/d)		FCR	
		1-21d	14-28d	1-21d	14-28d	1-21d	14-28d
Millet diets ¹	9	-0.45 ^a	-5.97 ^A	0.12	1.73 ^A	1.34 ^a	1.82 ^a
Sorghum diets ²	12	0.60 ^a	-6.71 ^a	-0.02	-1.94 ^B	1.64 ^b	2.27 ^b
Cottonseed meal diets ³	7	3.20 ^b	5.69 ^B	0.61	-0.16 ^A	1.49 ^{ab}	2.31 ^b
SEM		0.54	2.00	0.38	0.94	0.04	0.06
<i>P-value</i>		***	*	NS	*	***	**

ADFI = average daily feed intake; BWG = body weight gain; FCR = feed conversion ratio; a, b, c: values within the same column with no common superscripts differ significantly at $P < 0.05$. A, B, C: have a trend at $P < 0.10$. *** $P < 0.001$; ** $P < 0.01$; * $P < 0.05$; NS not significant at $P > 0.10$.

¹From Davis et al., 2003; Hidalgo et al., 2004; Manwar and Mandal, 2009; Baurhoo et al., 2011; Goodarzi Boroojeni et al., 2011.

²From Douglas et al., 1990; Nyachoti et al., 1996; Jacob et al., 1996a,b; Kwari et al., 2011; Torres et al., 2013.

³From Henry et al., 2001; Sterling et al., 2002; Diaw et al., 2010.

Table 2. Response of ADFI, BWG and FCR to variations in level of substitution from 1-21d

	ADFI (g/b/d)					BWG (g/b/d)					FCR				
	Coef.	SE	<i>P-value</i>	R ²	RMSE	Coef.	SE	<i>P-value</i>	R ²	RMSE	Coef.	SE	<i>P-value</i>	R ²	RMSE
Millet															
Intercept	38.61	2.44	***			27.03	1.23	***			1.36	0.08	***		
Level of substitution	0.00	0.01	<i>NS</i>	0.09	5.80	0.00	0.01	<i>NS</i>	0.01	2.67	0.00	0.00	<i>NS</i>	-0.01	0.18
Sorghum															
Intercept	39.63	7.24	***			27.83	5.47	***			1.48	0.12	***		
Level of substitution	0.02	0.03	<i>NS</i>	0.00	12.78	0.00	0.02	<i>NS</i>	-0.01	9.88	0.00	0.00	<i>NS</i>	-0.02	0.30
Cottonseed meal															
Intercept	50.32	6.49	***			34.55	4.92	***			1.44	0.03	***		
Level of substitution	0.25	0.06	**	-0.01	8.04	0.11	0.05	*	-0.04	6.18	0.00	0.00	0.045	0.14	0.06

Table 3. Response of ADFI, BWG and FCR to variations in level of substitution from 14-28d

	ADFI (g/b/d)					BWG (g/b/d)					FCR				
	Coef.	SE	<i>P-value</i>	R ²	RMSE	Coef.	SE	<i>P-value</i>	R ²	RMSE	Coef.	SE	<i>P-value</i>	R ²	RMSE
Millet															
Intercept	124.4	9.75	***			63.14	5.76	***			1.87	0.15	***		
Level of substitution	-0.15	0.09	<i>o</i>	0.26	19.0	0.07	0.03	*	0.08	10.5	0.00	0.00	<i>NS</i>	-0.03	0.29
Sorghum															
Intercept	110.0	20.67	***			49.89	10.7	***			2.19	0.22	***		
Level of substitution	-0.11	0.05	<i>o</i>	-0.02	35.3	-0.04	0.02	*	0.03	17.8	0.00	0.00	<i>NS</i>	0.05	0.41
Cottonseed meal															
Intercept	140.6	14.87	***			63.16	7.97	***			2.38	0.11	***		
Level of substitution	0.25	0.15	<i>NS</i>	-0.03	17.5	0.10	0.11	<i>NS</i>	-0.05	10.5	0.00	0.00	<i>NS</i>	-0.05	0.20

*** P<0.001; ** P < 0.01; * P < 0.05; *o* P < 0.10. RMSE = root mean square error