



The factors influencing sorghum starch digestibility in meat chickens

Introduction

The contention is that the quality of sorghum as a feed grain for chicken-meat production is better than its perceived value; nevertheless, there is clearly scope for improvement. There is a distinct possibility that this improvement could be realised if grain breeding programs focused on developing sorghums with lesser kafirin proportions of total protein and sorghums with lesser concentrations of polyphenols. The likelihood is that poultry offered such sorghum-based diets would respond more robustly to dietary inclusions of phytate-degrading feed enzymes, which would be advantageous.

Key Findings

The digestion of starch by poultry offered sorghum-based diets is deficient as reflected by the mean distal ileal starch digestibility coefficient of 0.866 (range: 0.793 to 0.918) across five feeding studies in this project. It was established that the utilisation of starch/energy by meat chickens offered sorghum-based diets is suboptimal for which three causal factors were identified.

- Kafirin is the dominant protein in grain sorghum but it was shown to depress energy utilisation. The likelihood is that kafirin impedes digestion of starch by amylase.
- ‘Non-tannin’ phenolic compounds (polyphenols and phenolic acids) were shown to have the capacity to depress energy utilisation. It appears that phenolic compounds both retard starch digestion and hinder glucose absorption.
- Phytate is a recognised anti-nutritive factor that is present in all feedstuffs of plant origin. However, concentrations of phytate and phenolic compounds appear to be positively related in grain sorghum and, in tandem, these sorghum components may be amplifying compromised starch/energy utilisation.

Implications

This study provides evidence that concentrations of kafirin and Non-tannin phenolic compounds in sorghum are compromising efficiency of energy utilisation in chickens offered sorghum-based diets. Thus, there should be a preference for low-kafirin, white sorghums as a feed grain for chicken-meat production. A white sorghum will contain less polyphenols, probably less phenolic acids, and ideally it would have low protein contents with small kafirin proportions of sorghum protein. This ‘ideal’ sorghum variety would still contain phytate but this can be addressed by the inclusion of exogenous phytases in sorghum-based diets.





Publications

The bulk of this research was published in the articles below, and are open access (meaning there is no restriction on accessing the full publication).

1. Truong HH, Cadogan DJ, Liu SY, Selle PH (2016) Addition of sodium metabisulphite and microbial phytase individually and in combination, to a sorghum-based diet for broiler chickens from 7 to 28 days post-hatch. *Animal Production Science* 56, p1484-1491.

Weblink: <http://www.publish.csiro.au/AN/pdf/AN14841>

2. Selle PH, Truong HH, Khoddami A, Moss AF, Roberts TH, Liu SY (2016) The impacts of hammer-mill screen size and grain particle size on the performance of broiler chickens offered diets based on two red sorghum varieties. *British Poultry Science* 12, p1-10.

Weblink: <http://www.tandfonline.com/doi/full/10.1080/00071668.2016.1257777>

3. Liu SY, Truong HH, Khoddami A, Moss AF, Thomson PC, Roberts TH, Selle PH (2016) Comparative performance of broiler chickens offered ten equivalent diets based on three grain sorghum varieties as determined by response surface mixture design. *Animal Feed Science and Technology* 218, p70-83.

Weblink: [http://www.animalfeedscience.com/article/S0377-8401\(16\)30186-9/fulltext](http://www.animalfeedscience.com/article/S0377-8401(16)30186-9/fulltext)

4. Truong HH, Neilson KA, McInerney BV, Khoddami A, Roberts TH, Cadogan DJ, Liu SY, Selle PH (2017) Comparative performance of broiler chickens offered nutritionally-equivalent diets based on six diverse, 'tannin-free' sorghum varieties with quantified concentrations of phenolic compounds, kafirin, and phytate. *Animal Production Science* 57, p.828–838.

Weblink: <http://www.publish.csiro.au/AN/pdf/AN16073>

5. Truong HH, Neilson KA, McInerney BV, Khoddami A, Roberts TH, Liu SY, Selle PH (2016) Sodium metabisulphite enhances energy utilisation in broiler chickens offered sorghum-based diets with five different grain varieties. *Animal Feed Science and Technology* 219, 159-174.

Weblink: <http://www.sciencedirect.com/science/article/pii/S0377840116302577>

Ancillary open access papers to the sorghum starch project

• Liu SY, Fox G, Khoddami A, Neilson KA, Truong HH, Moss AF, Selle PH (2015) Grain sorghum: a conundrum for chicken-meat production. *Agriculture* 5(4), 1224-1251.

Weblink: <http://www.mdpi.com/2077-0472/5/4/1224/htm>

• Truong HH, Neilson KA, McInerney BV, Khoddami A, Roberts TH, Liu SY, Selle PH (2015a) Performance of broiler chickens offered nutritionally-equivalent diets based on two red grain sorghums with quantified kafirin concentrations as intact pellets or reground mash following steam-pelleting at 65 or 97°C conditioning temperatures. *Animal Nutrition* 1(3), 220-228.

Weblink: <http://www.sciencedirect.com/science/article/pii/S2405654515300172>





- Selle PH, Truong HH, McQuade LR, Moss AF, Liu SY (2016) Reducing agent and exogenous protease additions, individually and in combination, to wheat- and sorghum-based diets interactively influence parameters of nutrient digestibility and digestive dynamics in broiler chickens. *Animal Nutrition* 2(4), p303-311.

Weblink: <http://www.sciencedirect.com/science/article/pii/S2405654516301184>

- Truong HH, Khoddami A, Moss AF, Liu SY Selle PH, (2017) The potential of rapid visco-analysis starch pasting profiles to gauge the quality of sorghum as a feed grain for chicken-meat production. *Animal Nutrition* 3(1), p11-18.

Weblink: <http://www.sciencedirect.com/science/article/pii/S2405654516301536>

- 10 Sorghum Technotes are available at the Feed Grain Partnership website.

Weblink: http://feedgrainpartnership.com.au/fgp_activities/information_sharing_technotes/

Recommendations

- Most importantly, sorghum breeders should be encouraged to select for 'low-kafirin' sorghums. Classically, kafirin constitutes 55% of sorghum protein and the objective should be to reduce this proportion, irrespective of the total sorghum protein content, if this is at all feasible, and without compromising the agronomic properties of sorghum.
- Red sorghums constitute perhaps 95% of the Australian crop. There should be incentives for sorghum growers to plant more white variety sorghums to reduce dietary phenolic compound concentrations in comparison to red sorghum-based poultry diets. This initiative would be facilitated if sorghum breeders were to focus on the development of more white varieties and if feed-mills and integrated operations were to consider paying a premium for white over red sorghum varieties.
- The development of 'low-kafirin' white sorghum varieties have lower starch gelatinisation temperatures and softer grain textures. This should result in both better pellet quality and better bird performance. There is also the real possibility that these varieties would allow more robust responses to phytase supplementation of sorghum-based diets, which would be a distinct advantage.
- The evaluation of sorghum (and other feedstuffs) deliveries to feed-mills by RVA starch pasting profiles and Promatest protein solubilities for feed grain quality is an approach that should be investigated further. Equally, the inclusion of reducing agents such as sodium metabisulphite in sorghum-based diets should be investigated further with the caveat that their merits in 'low-kafirin' sorghum-based diets may be diminished.



More Information

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RIRDC Project No PRJ-008695

Pub. No 17/014

ISBN: 978-1-74254-938-5

