

Effect of Duration of Stacking on the Nutritional Profile of Sorghum Spent Grain and the Effects of its Dietary Inclusion on the Performance of Broilers

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Abstract: Fresh Sorghum spent grain (SSG) from local beer commonly called Dussa collected from local production centers was divided into three parts to evaluate the effect of duration of stacking on the nutrient profile and the effects of its subsequent dietary inclusion on the performance of broiler chickens. One part of the SSG was sundried fresh to obtain fresh sun dried SSG (FSSG), the second part was sundried after stacking for 48 hours to obtain (STK48) while the third part was sundried after stacking for 72 hours to obtain STK72. The differently processed SSG was analyzed for the proximate composition and thereafter included in broiler feeds. Seven experimental diets were formulated with diet 1 serving as the control without sorghum spent grain. Each treatment consists of two levels (i.e. 15 and 30% inclusion). Diets 2, 4 and 6 had 15% fresh, STK48 and STK72 inclusion respectively, Diets 3, 5 and 7 had 30% fresh, STK48 and STK72 respectively. 140 day old arbor acre strain of broilers was used for the experiment. The birds were randomly assigned to seven dietary treatments after weight balancing. The treatments were replicated four times at the rate of five birds per replicate to make 20 birds per treatment in a completely randomized design (CRD) experiment in a factorial arrangement. The results of the processing showed a slight numerical variations on the nutrient composition of sorghum spent grain (SSG) as the stacking period's increases (Crude protein rose from 20.52 (FSSG) to 21.17 for STK72, while the fibre did not show noticeable reduction. Broilers fed fresh sun dried SSG had highest ($P < 0.05$) final weight (1.81kg) while the birds fed STK72 had the lowest ($P < 0.05$), (1.56kg). Effect of inclusion levels shows higher performance (1.80kg) at 15% inclusion and the least value (1.57kg) was observed at 30% inclusion compare with the control diet (1.70kg). The processing methods and inclusion levels had a negative interaction effect on the final weight gain, daily weight gain but positive effect (reduction in feed intake as the stacking and inclusion levels increased) on daily feed intake of the broilers at STK72 and 30% inclusion level. It could be concluded that, up to 15% inclusion of SSG and freshly sundried SSG can be used in the diet of broilers without adverse effects on performance.

Keywords: Sorghum spent grain, Stacking, Nutrient profile, Sorghum

1. Introduction

Foods of animal origin are important sources of nutrients in the human diet and will continue to play an increasing role in human nutrition [1]. This is because animal protein has balance amino acid profile [2]. Poultry especially broilers is considered a faster means of achieving animal protein availability and consumption because it has fast growth rate and according to [3], poultry meat production has unique trait and now occupies second place in terms of volume of meat produced in the world market. Research has shown that poultry meat industry is more dynamic than the egg industry over the years [4] and two justifications for broiler production are their fast growth rate and efficient feed conversion.

The broiler feeds represents between 60-80% of the total cost of production out of which maize occupies the highest percentage and it thus appears there is currently no globally acceptable alternative to it in terms of energy supply [5]. Over the years, the bulk of research has centered on how to reduce cost of animal protein through the use of non-conventional feed resources, but the challenge is how to ensure the continuous supply of this at low cost for the populace. Several unconventional ingredients have been investigated in recent years for instance Bambara Seed (*Vigna subterranean* (L)), as replacement for soybean meal

[6], yam peel meal substituted for maize [7] and addition of degrading enzymes in the poultry diets [8].

Sorghum (*Sorghum bicolor* (L) moench), locally called guinea-corn, is one of the most extensively grown cereal grain in Nigeria [9], this is because the crop is environmentally friendly; water efficient and it requires little or no fertilizer or pesticides for its cultivation [10]. In the savannah and the semi-arid regions of Nigeria, millions of people consume sorghum as staple foods [11]. It is high in energy and most time recommended for the infants, pregnant and lactating mothers, the elderly and the convalescent. Apart from direct consumption, sorghum is used as raw material for large and small beer brewing industries and local beer called 'Brukutu' and most time stacked for two to three days before selling to pig farmers. This residue (sorghum spent grain) from local beer producing industries was processed in this study to determine the proximate composition and to evaluate the nutritional potential it holds for broiler production.

2. Materials and Methods

Site: The experiment was carried out at the Poultry Unit of the Teaching and Research Farm of the University of Ibadan, Ibadan, and the place is located within longitude

7°20'N, 3°50'E, altitude of approximately 200m above sea level.

Collection and processing of test ingredients

Sorghum Spent Grain (SSG) locally called "Dussa" was procured from a local producing mill at the army barrack Mokola Ibadan, Oyo state, Nigeria. It was divided into three parts, one part of the test ingredient was sundried immediately to obtain the fresh SSG (FSSG), the second part was stacked for forty-eight hours before sun drying to obtain stacked 48 hours SSG (STK48) while the third part was stacked for seventy-two hours before sun drying to obtain stacked 72 hours SSG (STK72). Each part of the test ingredient was sundried until constant weight (Moisture content of 9.8, 9.82 and 9.76 for FSSG, STK48, and STK72 respectively) was obtained.

Formulation of experimental diets

Seven experimental diets were formulated with diet 1 serving as the control. Diets 2 and 3 had 15 and 30% inclusion of fresh sorghum spent grain (FSSG), diets 4 and 5 had 15 and 30% of stacked forty-eight hours SSG (STK48) and diets 6 and 7 had 15 and 30% stacked seventy-two hours SSG (STK72) respectively (Tables 2 and 3).

Experimental Animals and management

One hundred and forty (140) day old arbor acre broiler chicks were used for the study. The birds were weighed on arrival at the farm (Initial weight) and thereafter weekly. Using randomized completely design in a 3x2 factorial arrangement, the birds were assigned to seven treatments with four replicates of five birds each. Birds were housed on deep litter. Vaccines were administered according to the prevailing vaccination schedule in the environment. A known quantity of feed was offered daily at 8.00am and 4.00pm. Daily feed intake was calculated by difference between the feed offered and the left over. Data collected were analysed using the analysis of variance in a 3x2 factorial arrangement [12]. Means were separated using Duncan Multiple range test of the same statistical package.

3. Results and Discussion

The proximate analysis of the SSG is presented in Table 1. There was slight increase (20.52, 21.09, 21.17 for fresh, STK48, STK72 respectively) in the crude protein of the test ingredients. This may be as a result of microbial fermentation of the starchy sorghum material. This agrees with the report of [13] and [14], that fermentation enriches food with amino acids, vitamins, mineral, bioactive compounds and protein respectively. Also [15] also reported that fermentation improves nutritive value and digestibility while [16] reported that fermentation led to increase in vitamin and essential amino acid content. There was a reduction of fibre percentages as the stacking period increases. This can be as a result of microbial load especially fungi that help in the breaking down of hemicelluloses lignin complexes and because of fungi ability to invade and digest structural plant components, this agree with the report of [17]. The processed SSG in this study has a relatively high protein (20.52, - 21.17) compared with the value reported by [18]. Processing of SSG has been reported to promote

growth performance in various species of animal like ruminants, pig, rabbit, broilers and layers [19 and 20].

The performance of broiler as affected by the treatment effects is presented in Table 4. Fresh SSG recorded the highest ($P < 0.05$) (1.81kg) average final live weight while stacked STK72 recorded the lowest final live weight (1.56kg/bird). Daily weight gain and daily feed intake/bird followed similar trend except for the control birds that had similar ($P > 0.05$) value with STK72. This could be as a result of reduction in the tensile strength of the SSG, the colour change and foul odour as the stacking period increases. Birds have innate preference for food of certain colour and odour [21 and 22]. Long stacking of SSG had influence on the colour and odour (deep brown and foul/pungent smelling). However [23] reported odourless fermented SSG after many days as a result of 0.5% formalin addition. Although the SSG has been reported to support growth [19 and 20], reduction in the broilers' performance as stacking period increases experienced in this study may be an indication of the effect on the utilization capacity of the gut to increase stacking period. This is in consonance with report of Yegani and Korver, [24], although the histology of the organs was not done to verify this claim.

Table 5 shows the main effect of inclusion levels of SSG on the performance characteristics of the broilers at finishing phase. Level of inclusion significantly ($P > 0.05$) affected the final weight of the birds. Average final body weight values (1.80kg) of birds on T_2 15% inclusion level were significantly ($P < 0.05$) higher than the values recorded for birds on control: 1.70kg and 30% inclusion level: 1.57kg). T_2 (15% inclusion) recorded highest (32.13g/bird/day) daily weight gain while 30% inclusion level recorded the lowest value of 28.00g/bird/day. The values obtained for daily feed intake are 74.35, 80.02, 77.79g for control, 15% and 30% inclusion respectively. The feed conversion ratio of control and 15% inclusion level (2.45 and 2.47) were similar ($P > 0.05$) and better compared to 30% inclusion (2.78). The weight gain and FCR of the different inclusion showed significant differences ($P < 0.05$) with birds on 15% inclusion level having the highest final body weight (1.70kg) and was able to convert their feed better like control birds. T_3 (30% inclusion level) recorded the lowest final body weight of 1.56kg, this may be as a result of high fibre percentage in the diet as the inclusion levels increases, earlier [25 and 14] reported that the effect of dietary fibre on performance was dependent on the source and concentration of the fibre source thus corroborating [26], who reported that different fibre sources will elicit diverging performance responses because different dietary fibre source are known to be compositionally different from each other.

Table 6 shows the interaction effect of treatment and inclusion levels. The processing methods and inclusion levels had a negative interaction effect on the final body weight, daily weight gain but positive effect on daily feed intake of the broilers fed STK72 and at 30% inclusion level. As the level of inclusion increases with the increase number of the day of stacking, there were significant ($P < 0.05$) decrease in the final body weight from 1.74 (control) to 1.38 (STK72) while the daily feed intake reduces as the two factors interact from 85.00g (control) to 68.72g (STK72).

Supplementation of broiler diets with freshly dried SSG is a practical approach to reduce competition for maize between man and animal. The results of this study indicated that freshly dried SSG holds better potential in broiler production and should not be use after 48hours in order to ensure better broiler performance, However,15% inclusion is considered suitable to avoid lower weight observed with higher inclusion level.

4. Conclusion

Stacking had slight positive effect on the nutrient profile of sorghum spent grain. Growth was adversely affected by the processing method and inclusion levels. From the results of this study, the use of fresh SSG at 15% inclusion in the diets of broilers chicken is recommended and stacking is not necessary, as it is time wasting and costly.

Table 1: Proximate composition of differently stack sorghum spent grain (SSG)

| Parameters | Samples | | |
|-----------------------|-----------|-------|-------|
| | Fresh SSG | STK48 | STK72 |
| Crude Protein | 20.52 | 21.09 | 21.17 |
| Fat | 5.35 | 5.37 | 5.42 |
| Fibre | 15.38 | 15.13 | 15.10 |
| Ash | 7.81 | 7.74 | 7.56 |
| Nitrogen free extract | 50.99 | 50.67 | 50.76 |
| Dry matter | 90.20 | 90.18 | 90.24 |

FSSG= Fresh SSG, STK48= Fresh SSG stacked for 48 hours, STK72= Fresh SSG stacked for 72 hours

Table 2: Gross Composition of Broiler Starter Diets

| Ingredients(%)/Diets | T1 | T2 | T3 | T4 | T5 | T6 | T7 |
|------------------------------|---------------|---------------|---------------|---------------|---------------|---------------|---------------|
| Maize | 57.19 | 46.62 | 35.65 | 46.62 | 35.65 | 46.62 | 35.65 |
| SBM | 37.00 | 30.27 | 23.54 | 30.27 | 23.54 | 30.27 | 23.54 |
| SSG | 0.00 | 15.00 | 30.00 | 15.00 | 30.00 | 15.00 | 30.00 |
| Veg. oil | 0.00 | 2.50 | 5.00 | 2.50 | 5.00 | 2.50 | 5.00 |
| Fish Meal | 2.50 | 2.50 | 2.50 | 2.50 | 2.50 | 2.50 | 2.50 |
| L/Stone | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 |
| DCP | 1.50 | 1.50 | 1.50 | 1.50 | 1.50 | 1.50 | 1.50 |
| Methionine | 0.14 | 0.14 | 0.14 | 0.14 | 0.14 | 0.14 | 0.14 |
| Lysine | 0.12 | 0.12 | 0.12 | 0.12 | 0.12 | 0.12 | 0.12 |
| Salt | 0.30 | 0.30 | 0.30 | 0.30 | 0.30 | 0.30 | 0.30 |
| Premix | 0.25 | 0.25 | 0.25 | 0.25 | 0.25 | 0.25 | 0.25 |
| Total | 100.00 | 100.00 | 100.00 | 100.00 | 100.00 | 100.00 | 100.00 |
| Calculated Nutrients: | | | | | | | |
| ME (Kcal/kg) | 3033.36 | 2962.37 | 2892.57 | 2962.37 | 2892.57 | 2962.37 | 2892.57 |
| Crude Protein | 23.63 | 22.80 | 21.96 | 22.80 | 21.96 | 22.80 | 21.96 |
| Energy:Protein Ratio | 128.30 | 129.93 | 131.72 | 129.93 | 131.72 | 129.93 | 131.72 |

T₁= control, T₂=Fresh sorghum spent grain (SSG), T₃=Fresh SSG Stacked for 48hours, T₄= Fresh SSG stacked for 72hour

Table 3: Gross Composition of Broiler Finisher Diets

| Ingredients(%)/Diets | T1 | T2 | T3 | T4 | T5 | T6 | T7 |
|------------------------------|---------------|---------------|---------------|---------------|---------------|---------------|---------------|
| Maize | 66.00 | 56.88 | 48.93 | 56.88 | 48.93 | 56.88 | 48.93 |
| SBM | 28.89 | 23.01 | 15.96 | 23.01 | 15.96 | 23.01 | 15.96 |
| SSG | 0.00 | 15.00 | 30.00 | 15.00 | 30.00 | 15.00 | 30.00 |
| Fish Meal | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 |
| L/Stone | 2.00 | 2.00 | 2.00 | 2.00 | 2.00 | 2.00 | 2.00 |
| DCP | 1.30 | 1.30 | 1.30 | 1.30 | 1.30 | 1.30 | 1.30 |
| Methionine | 0.14 | 0.14 | 0.14 | 0.14 | 0.14 | 0.14 | 0.14 |
| Lysine | 0.12 | 0.12 | 0.12 | 0.12 | 0.12 | 0.12 | 0.12 |
| Salt | 0.30 | 0.30 | 0.30 | 0.30 | 0.30 | 0.30 | 0.30 |
| Premix | 0.25 | 0.25 | 0.25 | 0.25 | 0.25 | 0.25 | 0.25 |
| Total | 100.00 | 100.00 | 100.00 | 100.00 | 100.00 | 100.00 | 100.00 |
| Calculated Nutrients: | | | | | | | |
| ME(Kcal/kg) | 3073.75 | 2868.92 | 2714.52 | 2868.92 | 2714.52 | 2868.92 | 2714.52 |
| Crude Protein | 19.96 | 19.64 | 19.04 | 19.64 | 19.04 | 19.64 | 19.04 |
| Energy:ProteinRatio | 153.99 | 146.08 | 148.99 | 146.08 | 148.99 | 146.08 | 148.99 |

T₁= control, T₂=Fresh sorghum spent grain (SSG), T₃=Fresh SSG Stacked for 48hours, T₄= Fresh SSG stacked for 72hour.

Table 4: Effect of Pre-treatment methods of sorghum spent grain on the performance characteristics of Broiler chickens

| Parameters | Treatment methods | | | | SEM |
|---------------------------|---------------------|--------------------|---------------------|--------------------|------|
| | T ₁ | T ₂ | T ₃ | T ₄ | |
| Initial weight (g)/bird | 39.45 | 39.37 | 39.38 | 39.08 | - |
| Final weight (kg)/bird | 1.70 ^{ab} | 1.81 ^a | 1.67 ^{ab} | 1.56 ^b | 0.08 |
| Daily wt gain(g)/bird | 30.35 ^{ab} | 32.27 ^a | 30.12 ^{ab} | 27.81 ^b | 1.33 |
| Daily feed intake(g)/bird | 74.35 ^b | 83.39 ^a | 80.60 ^a | 72.74 ^b | 2.07 |
| FCR | 2.48 ^b | 2.49 ^b | 2.69 ^a | 2.64 ^a | 0.08 |

^{ab}: Mean within rows with different superscript differed significantly (P<0.05), FCR= Feed conversion ratio, T₁= control, T₂=Fresh sorghum spent grain (SSG), T₃=Fresh SSG Stacked for 48hours, T₁= Fresh SSG stacked for 72hours.

Table 5: Effect of inclusion level of processed SSG on the performance of Broiler Chickens

| Parameters | Inclusion levels | | | SEM |
|-----------------------------|---------------------|----------------------|----------------------|------|
| | T ₁ (0%) | T ₂ (15%) | T ₃ (30%) | |
| Initial weight(g)/bird | 39.45 | 37.77 | 39.08 | - |
| Final body weight (kg)/bird | 1.70 ^{ab} | 1.80 ^a | 1.57 ^b | 0.07 |
| Daily weight gain (g)/bird | 30.35 ^{ab} | 32.13 ^a | 28.00 ^b | 1.10 |
| Daily feed intake (g)/bird | 74.35 | 80.02 | 77.79 | 2.34 |
| FCR | 2.45 ^b | 2.47 ^b | 2.78 ^a | 0.07 |

^{ab}: Mean within rows with different superscript differed significantly (P<0.05), FCR= Final weight gain, T₁= control, T₂ =15% inclusion level of SSG, T₃=30% inclusion level of SSG.

Table 6: Interactive Effects of Processing Methods and Inclusion levels on the Performance of Broiler Chickens fed Fresh and Stacked Sorghum Spent Grains

| Parameters | Inclusion levels (%) | Processing Methods | | | SEM |
|--------------------|----------------------|--------------------|--------------------|--------------------|------|
| | | Fresh | SK48 | SK72 | |
| Initial weight (g) | 0 | 39.45 | 39.45 | 39.45 | 0.00 |
| | 15 | 37.50 | 39.05 | 38.75 | 0.00 |
| | 30 | 39.45 | 38.45 | 39.70 | 0.00 |
| | SEM | 0.02 | 0.00 | 0.00 | |
| Final weight (kg) | 0 | 1.70 | 1.70 | 1.70 | 0.00 |
| | 15 | 1.87 | 1.79 | 1.74 | 0.05 |
| | 30 | 1.74 ^a | 1.59 ^a | 1.38 ^b | 0.06 |
| | SEM | 0.03 | 0.04 | 0.04 | |
| Daily gain (g) | 0 | 30.35 | 30.35 | 30.35 | 2.27 |
| | 15 | 33.38 | 31.96 | 31.06 | 0.87 |
| | 30 | 31.16 ^a | 28.29 ^a | 24.55 ^b | 0.97 |
| | SEM | 1.24 | 1.38 | 1.49 | |
| Daily FI (g) bird | 0 | 74.35 | 74.35 | 74.35 | 3.23 |
| | 15 | 81.78 | 81.54 | 76.76 | 2.08 |
| | 30 | 85.00 ^a | 79.67 ^a | 68.72 ^b | 2.23 |
| | SEM | 1.72 | 2.44 | 3.39 | |
| FCR | 0 | 2.48 | 2.48 | 2.48 | 2.48 |
| | 15 | 2.46 | 2.55 | 2.47 | 0.03 |
| | 30 | 2.73 | 2.82 | 2.80 | 0.04 |
| | SEM | 0.06 | 0.08 | 0.08 | |

^{ab}: Mean within rows with different superscript differed significantly (P<0.05),FCR= feed conversion ratio, FI= feed intake, SK48= Fresh sorghum spent grain (SSG) stacked for 48hours, SK72= Fresh SSG stacked for 72 hours.

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