Effects of feeding different levels of dried brewery grains on egg quality parameters and laying performance

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Abstract

One of the key goals of poultry production is to decrease the expenses associated with feed. The by-product of brewing known as dried brewers' grains (DBG) may be a promising and cost-effective alternative to conventional feedstuff, such as maize and soybean meal. The aim of this review was to assess the impact of brewer's dried grains on the performance and quality of eggs produced by layer chickens under intensive management conditions. Fully dried grain has a dry matter content of 93%, a metabolize energy content of 2360 kcal/kg, a nitrogen-free extract content of 48.6%, and an ether extract content of 6.2%. In a study, adding BDG at a level of 18% to the chicks' diet could decrease production costs compared to the control diet, , which made it economically feasible. Moreover, it increased economic efficiency without having any negative effects on the chicks' feed intake, weight gain, or feed conversion efficiency. The quality of the albumen, yolk, and shell was unaffected by diets containing DBG. As the proportion of BSG in the rations increased, the feed cost decreased, primarily owing to its more affordable purchase price. It can be therefore concluded that adding DBG to the diet of layer chickens affects neither egg output nor quality, and it can even be financially beneficial.

Keywords: Brewery dried grain; Chicken; Egg quality; Productivity

Introduction

At least 65% of the overall cost of producing poultry is spent on feeding. One of the key objectives of chicken production is low feed costs (Alagawany et al., 2015; Alagawany and Attia, 2015). One of the main issues with chicken farming in Ethiopia is the cost and availability of feed. It is difficult to create appropriate poultry feeds due to a lack of protein sources, vitamins, and minerals in Ethiopia (Demeke Solomon, 2007). Due to the fierce competition humans face for the same foods, the price of conventional feed ingredients has significantly increased. As a result, it is now anticipated that the quest for alternate feed sources will decrease the cost of feed (Munthali et al. 1989). By reducing feed costs, which make up more than half of the whole cost of production, it is possible to increase the profit from poultry production (Zewedu and Berhanu, 2014). As a result, one of the best solutions for effective poultry production is the use of alternate feed sources in chicken rations (Zewedu and Berhanu, 2014). Brewery dried grains (DBG) could be utilized as an inexpensive substitute for conventional feed ingredients (such as soybean and corn meal). According to Taylor et al (2009), these substances are regarded as good providers of water-soluble vitamins and insoluble proteins.

"Brewers dried grain" is the leftover material from the fermentation of the grain used to produce beer. The by-product varies nutritionally in different plants depending on the type of substrate (barley, wheat, maize, etc.), the degree of fermentation, and the type of fermentative process (Levic et al., 2010). It is produced in enormous numbers and is freely or inexpensively accessible year-round (Mussatto et al., 2006; Tilahun et al., 2013).

Many of the vital ingredients required to create poultry feed are found in BDG. About 20% crude proteins (CP), 6% ether extract (EE), 15% crude fiber (CF), and 4% ash make up its composition. It also contains 0.9% lysine, 0.4% methionine, 0.4% tryptophan, 1.2% phenylalanine, 1.1% threonine, and 1.6% valine, among other reasonably high concentrations of important amino acids (Abd El-Hack ME et al., 2019). According to Longe and Adetolla (1983), DBG has 93% dry matter (DM), 22.4% CP, 19.1% CF, 4% ash, 48.6% nitrogen-free extract (NFE), 2360 kcal/kg of metabolizable energy (ME), and 6.2% EE.

Numerous research showed that as BDG levels increased, the overall cost of production and feed cost per kilogram reduced (Adama et al., 2007; Fasuyi et al., 2018). Corn seeds and soybean meal could be used less frequently in chicken feed because of the high CP and ME content of BDG. But BDG, or brewery waste dryer, is rarely utilized in chicken feed because of its high fiber content. BDG can be utilized in bird diet to some extent, per a number of research (Parson et al., 1983; Noll et al., 2001; Odunukan et al., 2016). Without affecting the chicks' feed intake, weight gain, or feed conversion efficiency, adding BDG at a level of 18% to their diet made it more economically feasible and efficient in comparison to the control diet (Zewdu and Berhan, 2014).

Ethiopia produces a considerable amount of yeasts and brewer's dry grains each year. A significant amount of this waste accumulates at production sites, creating disposal and public health concerns. Small amounts are used as fodder for dairy animals. This enormous byproduct has not yet been widely used as a source of chicken feed (Zewdu and Berhan, 2014). Therefore, the goal of this review was to assess the impact of brewer’s dried grains on the performance and quality of eggs produced by layer chickens under intensive management conditions.

Chemical composition of brewery dried grain

The DM content of the following percentages of brewery wasted grain (BSG) was determined: 92.00%, 91.80%, 94.30%, 91.01%, and 93.17% (NRC, 1994; Demeke Solomon, 2007; Fărcas et al., 2014; Zewdu and Berhan, 2014; John, 2015). The CP content of BDG was reported as follows when placed in ascending order and within the range of 28–30% reported in Mussatto et al. (2006): 18% by Fărcas et al. (2014), 23.67% by John (2015), 24% by Demeke Solomon (2007), 25% by Swain (et al., 2013), 25.8% by Heuze et al. (2015), 27% by Briggs et al. (2004), and 27.7% by Mafeni and Fombad (2001). The Ether Extract of Brewery Sent Grain was 4.35% (Mebrahtom et al., 2019), which is greater than the 3.06% reported by Zewdu and Berhan (2014) but lower than 5.06% (Swain et al., 2013), 6.30% (Demeke, 2007), 7.20% (Mafeni and Fombad, 2001), and 8.91% (John, 2015). As reviewed by Abd El-Hack ME et al., (2019), DBG contain minerals (g/kg DM): calcium (2.7), Phosphorus (5.7), Potassium (2.9), Sodium (0.3), Magnesium (2.6) and Manganese (47mg/kg DM), Zinc (89 mg/kg DM), Copper (19 mg/kg DM) and Iron (130mg/kg DM). As reviewed by Mussatto et al. (2006), DBG contain the vitamins (mg/kg): choline (1800), niacin (44), pantothenic acid (8.5), riboflavin (1.5), thiamine (0.7), pyridoxine (0.7), folic acid (0.2), and biotin (0.1).

The ash content of BDG was 3.80% (Mafeni and Fombad, 2001) which is lower than 3.86% reported by John (2015). Mebrahtom et al., 2019 found a higher ash concentration of 4.25%, which was comparable to 4.79% (Zewdu and Berhan, 2014) and 4-5% (Briggs et al., 2004). According to Swain et al. (2013), BSG had an ash content of 7.5. Mebrahtom et al. (2019) discovered that the CF level of BSG was (14.30%), which is similar to the values of 15% (NRC, 1994), 15.30% (Briggs et al., 2004), and 15.70% (Mafeni and Fombad, 2001), but significantly lower than 39.2% (John, 2015, Table 1).

Table 1. Chemical composition of brewery dried grain

Main analysis	Unit	Average	Source	Average	Source
Dry matter	(%) as fed	91.0	Swain et al. 2012.	77-81	Mussatto et al. 2006
Crude protein	(%) DM	28.1	Mebrahtom et al. 2019	25	Swain et al. 2012
Crude fiber	(%) DM	17.8	Demeke, 2007	12.3	Fasuyi et al. 2018
Ether extract	(%) DM	9	Denstadli et al. 2010	6.7	Swain et al. 2012
Ash	(%) DM	5.76	Senthilkumar et al., 2010	7.5	Swain et al. 2012
Ca	(g/kg) DM	2.7	Santos et al. 2003	3.38	Mebrahtom et al. 2019
P	(g/kg) DM	5.7	Mussatto et al. 2006	0.32	Mebrahtom et al. 2019
Niacin	Mg/kg	44	Mussatto et al. 2006		
riboflavin	Mg/kg	1.5	Mussatto et al. 2006		
thiamine	Mg/kg	0.7	Mussatto et al. 2006		

Feed intake

Ademosun (1973) states that the amount of BDG in starter and grower diets should not exceed 10% and 30%, respectively, depending on body weight gain, feed consumption, and efficiency. The study conducted by Adama et al. (2007) found that feed intake was similar up to 20% of the animals and subsequently increased to 40%. Onifade and Babatunde (1998) included three different levels (10%, 20%, and 30%) of BDG in broiler chicken diets and reported that feed consumption increased with increasing levels of BDG, but feed efficiency was similar at the 10% level but declined at the higher concentrate.

In the study by Tikunesh et al. (2023), the T5 ration, which included 26% BDG, had the highest feed intake, whereas the T1 ration, which had 0% BDG, had the lowest feed intake . This report was similar to those of Mafeni and Fombad (2001), who found that feed intake increased when the amount of brewery-dried grain in breeder chicken rations increased by up to 30%. According to Meseret et al. (2012), inclusion levels of 40% brewery dry grain led to high feed consumption by layer chickens. Chicken fed on a diet containing up to 25% brewery-dried grain showed no appreciable variation in feed consumption (Meseret et al., 2012). A study indicated that output of hen-housed eggs decreased as the quantity of BDG rise. Bovans brown chickens fed on rations with high levels of BGD produced fewer eggs and consumed more feed, which may have been caused by the diets' high fiber content (Tikunesh et al., 2023).

A higher feed conversion ratio (FCR) was observed in hens fed a diet contain T3, T4 and T5 compared with those of T1 and T2 diets. Higher feed conversion ratio means low feed efficiency which was obtained at higher inclusion level of brewery dried grain (Tikunesh et al., 2023). This finding disagrees with the reports of Kevin et al. (2006) who reported reduced feed conversion ratio at 40% levels of BDG inclusion.

Aghabeigi et al. (2013) evaluated the impact of gradual replacement of soybean meal with 0, 5%, 10%, 15%, 20% and 25% BDG on performance in chickens. They found that feed intake value in 0 and 5% BDG groups was increased compared to other groups, but feed conversion ratio was not affected by BDG inclusion (24 to 42 day). FCR (feed conversion ratio) of chicks fed the diet incorporated with 10% BDG was similar to those fed the basal diet, but FCR of chicken fed 20% BDG increased significantly (Swain et al., 2012). Lower feed intake by birds at high concentrations of BDG might result from high amount of fiber present in BDG (Abd El-Hack ME et al., 2019). Chicken on high levels of fiber diets consumed much feed but produced lesser number of eggs (Obidimma et.al., 2010). Selvan (2005) indicated that adding BDG at a 10% level to feed enhanced feed conversion ratio, decreased mortality, and decrease body weight gain in Japanese quails.

In birds fed high-BGD rations, increased feed intake resulted in decreased feed efficiency and decreased egg production; the high fiber content of the diets may have contributed to this outcome. The active ingredients in Bovans brown chickens may become less available with high-fiber diets (Tikunesh et al., 2023). The average daily feed intake (ADFI) of hens fed diets 1 and 2 (81.88 g and 82.26 g) was significantly lower than that of chicks fed diet 3 (95.06 g). This may be explained by diets 3's higher fiber content and lower metabolizable energy (MJ/kg) in comparison to diets 2 and the control (R. Olajide et al., 2016). The amount of feed that Bovans brown hens consumed tended to rise when the level of BDG increased (Mebrahtom Nguse et al., 2019). T5 (40%) had the most feed intake compared to T4 (30%), T3 (20%), T2 (10%), and T1 (0) (Mebrahtom Nguse et al., 2019). Due to its high fiber content, brewery dried grain should not be used in chicken feeds. The rations with high BDG concentration were less digestible due to their high fiber content (Abd El-Hack ME et al., 2019).

In laying quails fed a diet incorporating 5% BDG, there was a positive correlation observed in the egg weight, body weight, feed conversion ratio, and egg production characteristics (Swain B et al., 2013). In a similar vein, Selvan (2005) discovered that adding BDG to Japanese quails at a 10% level enhanced feed conversion ratio, boosted body weight gain, and decreased mortality. Better protein content and amino acid balance in the meal may be the cause of this increase in overall performance.

According to Tikunesh et al. (2023), T5 (26% BDG) had the highest fiber content, followed by T4 (19.5 BDG), and T1 (control) had the lowest. Diet 3 had the largest amount of fibre (95.06 g), followed by diet 2 (82.26 g), while diet 1 (control) had the least amount. It has been demonstrated that fibre alters the physical texture of the diet and causes chicken to consume more food to meet their energy requirements (Longe, 1984). T5 (26% BDG) had the most fibre content, followed by T4 (19.5 BDG), and T1 (control) had the least (Tikunesh et al., 2023.The insoluble portion of plant cell walls that animal enzymes cannot break down but that the gastrointestinal bacteria may partially break down is known as fiber in monogastric animals (Damoron and Sloan, 2009). According to John (2015), inclusions of high-fiber ingredients are often restricted because of the low metabolizable energy levels, which lower chicken performance and nutrient utilization usage. Growth, egg production, and feed efficiency are all negatively impacted by high crude fiber content in chicken diets.

Brewery dried grain and egg production

Brewers' dried grain, when added to the diet of Japanese quail layers at a rate of 5%, significantly increased egg production, egg weight, feed effectiveness, and profit margin. The output of hen-housed eggs decreased as the quantity of BDG rose. chicken fed on rations with high levels of BGD produced less eggs and consumed more feed, which may have been caused by the diets' high fiber content (Tikunesh et al., 2023).

Birds on high-fiber diets laid less eggs (Obidimma et al., 2010). Mafeni and Fombad (2001) and Yangtul et al. (2013) observed a considerable increase in egg weight when the BDG level rose to 30%. According to Rotimi et al. (2013), Isa-Brown laying hens fed diets 1 (0% BDG) and 2 (10% BDG) deposited 1.73 and 1.60 trays of eggs per bird, respectively, while those fed diet 3 (20% BDG) laid 2.04. Although economically advantageous and having a similar impact on internal egg quality, adding up to 26% brewery dry grain to the diet of Bovans brown layers decreased egg production (Tikunesh et al., 2023). By substituting 5% BDG for maize or soybean meal, egg production, feed conversion ratio, and egg weight were all considerably enhanced (Swain et al., 2013).

When BDG was fed at a 10% level, there was a considerable decrease in both egg production and the feed conversion ratio. Similar improvements were observed in egg production, egg weight, haugh unit, egg fertility, and hatchability in breeder layer hens fed 10% of a de-cellulosed combination of brewery by-products instead of 5% of maize in the control diet (Levic et al. 2010).

Brewery died grain and egg quality parameters

The anticipation of no significant difference in egg quality measures may result from the fact that greater BDG inclusion levels in the diet of Bovans brown chickesn have not considerably influenced feed intake or egg production (Mebrahtom et al., 2019. Tikunesh et al. (2023) reported that although T1 (0% BDG), yolk height was higher than T3 (13% BDG), it was similar to T2 (ration with 6.5% BDG included), T4 (19.5% BDG), and T5 (26% BDG) treatment groups. The same authors asserted that the range in yolk height (17.03-17.33 mm) was narrower in relation to the results (17.84 mm and 17.41 mm) published by Dessalew et al. (2015) for Bovans and Isa browns under village production method.

According to Mebrahtom et al. (2019), the quality of the albumen, yolk, and shell was unaffected by the BSG inclusion in the diets. Due to its reduced purchase price, feed costs did, however, fall as the amount of BSG in the rations increased. According to the same author, adding 40% BSG to a layer's diet can be both economically advantageous and has no effect on the quantity or quality of eggs produced. Breeder layer hens fed a 10% decellulosed mixture of brewery by-products showed a significant improvement in egg. According to Tikunesh et al. (2023), the albumen height range (6.71-6.83 mm) was similar to that reported by Yonas et al. (2019), who found that the mean albumen height for the Bovans brown breed was 7.1 mm. Tikunesh et al. (2023) reported that the Haugh unit (81.60–82.4) was similar to the values (82.15) reported by Niraj et al. (2014), according to Tikunesh et al. (2023), the outcome was not as significant as the one (87.45) reported for the same breed by Tadesse et al. (2015).

According to studies by Mafeni and Fombad (2001), a 30% BDG inclusion level dramatically decreased hen day egg yield while having no discernible impact on the parameters related to egg quality. According to Anyanwu et al. (2006), at a 37.5% BDG inclusion level, Haugh unit (HU) and albumen height are unaffected. The internal measures of egg quality, with the exception of yolk height and yolk color and score, were similar between treatments. The yolk color score decreased as the amount of dry grain from the brewery increase (Tikunesh et al., 2023). The quality of the (albumen, yolk, and shell) was unaffected by BDG. However, when the amount of BDG in the rations grew, the cost of feed decreased because of its lower buying price (Yangtul, et al., 2013). According to Melahtom et al. (2019), adding brewery leftover grain to layers' food at a rate of 40% has no effect on egg production or quality and may even be profitable. The addition of BDG to the diet of laying quail had no effect on the egg’s constituents, such as albumen, yolk, and shell percentage (Swain et al., 2013). According to Yalcin et al. (2008), feeding dried brewing yeast at a level of 1.5–4.5% in place of soybean meal did not result in any notable variations in the percentages of albumen, yolk, and egg shell.

External egg quality parameters

By substituting 5% BDG with maize or soybean meal, egg production, feed conversion ratio, and egg weight were all considerably enhanced in Japanese quail-laying hens (Swain et al., 2013). Swain et al. (2013) stated that the total number of eggs per hen decreased as the amount of dry grain from the brewery increased. T1 (0% BDG) had a larger total egg mass than T3 (13% BDG), T4 (19.5%), and T5 (26%), which all had similar values. According to Tikunesh et al. (2023), the hen-housed egg production was highest in T1(0% BDG). According to the same source, T1's (0% BDG) shell thickness was less than T3's (13% BDG), T4's (19.5% BDG), and T5's.

Egg shell thickness (0.39 mm) was found to be identical in Bovans Whites fed a combination of dried grain from breweries, jack beans, and cassava root meal, according to Uchegbu et al. (2011). Tikunesh et al. (2023) state that the egg thickness for Rhode Island Red was less than the egg shell thickness (0.39 mm) reported by Sinha et al. (2017). Higher egg shell thickness (0.41 mm) for Rhode Island Red fed under strict supervision was also noted by Niraj et al. (2014). According to Ahmedin and Mangistu (2016), the Bovans brown layer bree. The range of the egg shape index was 77.35-79.07 mm (Tikunesh et al., 2023) which is higher than 72-76 mm repored by Duman et al. (2016) and 76 mm by Liswaniso et al. (2020).

The T5 ration, which contained 40% BDG as an inclusion, had the lowest values with a percentage reduction of 2.03 and 9.86, respectively, whereas the T1 ration, which contained 0% BDG as an inclusion, had the highest egg weight (52.09g) and egg mass (30.63g/hen/day) (Swain et al., 2013). The same authors stated that feed conversion efficiency decreased constantly from T1 (ration containing 0% BDG as an inclusion) to T5 (ration containing 40% BSG as an inclusion). In laying quails fed a diet containing 5% BDG, the egg weight, body weight, feed conversion ratio, and egg production characteristics all showed a significant increase (Swain et al., 2013). Yalcin et al (2008) did not find significant differences in the percentages of albumen, yolk and egg shell due to feeding of dried brewery grain at (1.5-4.5%) level replacing soybean meal. However, the shell thickness was decreased significantly.

When varied amounts of BDG were provided to laying quails, the thickness of their shells dropped dramatically. This could be as a result of the high dietary fiber content in BDG diets, which may cause a decrease in calcium utilization and less calcium deposition in egg shell (Swain et al., 2013).

Economic aspects

With rising BDG levels, production costs and feed costs per kilogram fell (Abd El-Hack et al., 2019). Including a higher level of BDG produced the highest marginal rate of return (26%) and the rate of return dropped as the level of BDG declined. When compared to the control, adding up to 26% BDG provided a greater financial benefit and a similar effect on egg quality (Abd El-Hack et al., 2019)..

According to Swain et al. (2012), feeding Japanese quails with 10% BDG significantly reduced both the feed cost per kg and the feed cost per kg of weight increase. Adding up to 26% BDG yielded a similar effect on egg quality and offered a greater economic advantage over the control.

When it comes to profitability analysis similar findings by Mafeni and Fombad (2001) showed that adding more dried brewery grain 0, 10, 20, and 30%) to the ration gradually lowered the amount of feed needed to produce one kilogram of eggs. Mebrahtom et al. (2019) claimed that the lower cost of BSG led to a reduction in feed costs as the amount of BDG in rations increased. A 40% BDG inclusion in the diet of layers has no impact on egg production or quality, and it can even be financially advantageous.

According to Mebrahtom et al. (2019), adding up to 40% BSG offered greater economic benefits without compromising the supply of nutrients, laying efficiency, or egg quality. When the cost of feed per kilogram of food as well as the cost of rearing and selling were examined, no appreciable variations were found in broiler chickens fed diets supplemented with BDG (Adeniji et al., 2015).

The highest Marginal Rate of Return (MRR)=22.86 for T5 (40% BDG). The MRR continuously increased as the level of BSG increased from 10% in T2 to 40% in T5. Feed cost/dozen egg was the lowest in T5 showing a

21.35% reduction from the highest in T1. The decrease in feed cost between the control diet (6.60 birr per kg feed) and the diet with 40% inclusion level (4.50 birr per kg feed) represents a 31.19% reduction in the cost of feed which will be of great benefit to beneficiaries. The increase in egg sale/feed cost was continuous as BSG level increased along T1 to T5. The highest egg sale/feed cost 3.41 of T5 is by 27.24 percent higher than the lowest 2.68 of T1 (Gebremedihn et al., 2018).

Brewery dried grain and Digestibility coefficient

Ashour et al. (2019) found that broilers fed the 3% DBG diet had far higher crude protein digestion coefficients than the broilers fed the other experimental diets. The digestibility coefficient values for dry matter and crude fiber were unaffected by DBG. Aghabeigi et al. (2013) assessed the effects of gradually substituting different amounts of DBG for soybean meal on the digestibility of protein in grill chickens. When 10% DBG was added to diets, chicken samples that were killed at 42 days old had higher optimal protein digestibility than the 0%, 5%, 15%, and 20% DBG groups.

Because the DBG protein is insoluble, Denstadli et al. (2010) saw a decrease in protein digestibility when DBG replaced a control diet based on wheat and soy. These authors also noted that the addition of DBG to the diets caused a progressive drop in apparent ash availability, which they attributed to the complexation of DBG's fibrous structures with minerals. The Ether extract (EE), digestion coefficients decreased in chicks given 3% DBG levels. Adding BDG could boosted starch digestibility; this rise was likely caused by the course fiber particles in BDG, which may stimulate gizzard development and increase starch digestibility (Denstadli et al., 2010).

Conclusion

DBG (brewery dried grains) could be used as a low-cost alternative to traditional feed ingredients (soybean and maize meal). It is made in huge quantities and is reasonably priced all year round. These materials are thought to be excellent sources of insoluble proteins and water-soluble vitamins. Due to its high crude protein content, dried brewers' grain may be used in chicken diets in place of more soybean meal and maize grain. However, due to its high fiber content, DBG usage in chicken diets is restricted.

Because of its high fiber content, brewery-dried grain cannot be used in poultry feeds in large quantities. The poor metabolizable energy levels and high-fiber ingredients usually restrict the use of BDG, which has an impact on the performance and nutrient absorption of chicken. High levels of crude fiber in chicken diets have a negative impact on growth, egg production, and feed efficiency. Brewery-dried grain at low levels can be economically added to the diet of layers without affecting egg output or quality. Further research is required on diets that contain high concentrations of dried brewery grain and in combination with gredients for layer chickens. Further research is needed on the effects of dried brewery grain on layer chicken hatchability, fertility, and nutritional digestibility.

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Ethical consideration

The author declare and confirm that the manuscript is original, has no misconduc, has never been published in another journal and is confirmed to be published in this journal.

Conflict of interest

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