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Dried-distillers grains with solubles in the feeding of broiler chicken

Granos secos de destilería con solubles en la alimentación del pollo de carne

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Abstract

For this research, 100 one-day-old Cobb 500 chicken of both sexes were used in a feed trial with the following treatments: T_1, control diet; T_2, diet with 5% of DDGS-corn; T_3, diet with 10% of DDGS-corn; T_4, diet with 15% of DDGS-corn; With the purpose of determining the effect on food consumption, live weight gain, food conversion, economic merit and carcass weight and performance. The test was conducted under the conditions of a completely random design. Feeding was ad libitum and the trial had a span of 42 days. The presence of DDGS-corn caused a small but consistent increase in food consumption as the proportion of the product increased. The highest increase was in the first 14 days of age were achieved with 5% of the product, from 15 to 28 days with 10% of the product; when it finished, the control diet chickens had a better performance than those that ate DDGS. Likewise, with 10%, it was achieved the closest food conversion to the control group. and the economic earn was slightly higher, because it allowed to replace part of the soybean that is considerably more expensive; The best carcass weight and yield were achieved with 10% of DDGS in the diet.
Keywords: DDGA, feeding, broiler chicken.

Resumen

Se emplearon 100 pollos Cobb 500 de un día de edad, de ambos sexos, en un ensayo de alimentación con los siguientes tratamientos: T1, dieta testigo; T2, dieta con 5% de DDGS-maíz; T3, dieta con 10% de DDGS-maíz; T4, dieta con 15% de DDGS-maíz; con la finalidad de determinar el efecto sobre el consumo de alimento, incremento de peso vivo, conversión alimenticia, mérito económico y peso y rendimiento de carcasa. El ensayo se condujo bajo la condiciones de un diseño completamente al azar. La alimentación fue ad libitum y el ensayo tuvo una duración de 42 días. La presencia de DDGS-maíz motivó un pequeño pero consistente incremento en el consumo de alimento conforme se incrementó la proporción del producto; con 10% de DDGS-maíz se logró incremento de peso acumulado similar al del testigo, los mejores incrementos en los primeros 14 días de edad se lograron con 5% del producto, de los 15 a 28 días con 10% del producto, en el acabado el testigo superó a los tratamientos con DDGS. Así mismo, con 10% se logró la conversión alimenticia más próxima a la del testigo y el mérito económico fue ligeramente mejor, debido a que permitió reemplazar parte de la torta de soja que es considerablemente más cara; el mejor peso y rendimiento de carcasa se logró con 10% de DDGS en la dieta.
Palabras clave: DDGA, alimentación, pollos de carne.

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Introduction

The manufacturing of ecological fuel, also called biofuel, leaves a set of by-products that if are not used, they become agents of pollution. For many people, one of the logical uses of them is feeding, for both humans and animals.

These by-products are known as Distillers Dried Grains with Solubles (DDGS), the loss of soluble carbohydrates generates the increase of proteins and other components that may provide corn with a productive performance different from the commonly expected. However, its evaluation as a component of the diet under local conditions is needed, because producers complaint about some disadvantages that could be related to its use.

DDGS are being introduced in Lambayeque, although under local conditions the effect of their inclusion in the diet upon the living broilers output has not been evaluated; it is necessary to quantify their effect for the local producer to know what its true potential is. Understanding the output of broiler as increments of live weight, feed conversion, economic merit, weight, and performance of carcass; it is possible to make the following question:

Would it be possible to have an adequate output in broilers feeding them with diets containing DDGS?

To answer this question, the test described in the present article was implemented considering as a hypothesis: The inclusion of DDGS in the diet of broilers will allow to perform the analysis of the output behavior expressed through the increment of weight, feed conversion, economic merit, weight and carcass performance; considering the relationship these variables have with the feed consumption.

The following **objectives have been set:** to determine and analyze the feed intake of broilers, which receive increasing proportions of DDGS in their feed.

To determine and analyze the behavior of live weight and changes in weight. To determine and analyze the efficiency of feed utilization to gain live weight through feed conversion.

To determine and analyze the economic efficiency of the feed through the economic merit.

To determine and analyze the weight and performance of carcass.

According to FAO (2012), humans are facing with major environmental challenges as a result of climate change and an expected shortage of fossil fuels used for transport. The causes related to climate change are not fully understood, but it is accepted that emissions of greenhouse gases, especially methane, are a contributing factor over which we can exercise some control. The same organization mentions that the scarcity of fossil fuels can be mitigated by the combination of fossil fuels and biofuels, whether ethanol with petrol or biodiesel with diesel, both of which cause a reduction in carbon emissions, by what has been agreed in the fixing of minimum rates of inclusion. However, biofuel production comes, commonly, from agricultural crops, usually cereals that contain starch to ethanol and seed-oil crops for biodiesel. For this proposal to be successful it must be economically sustainable and must not generate conflict with the traditional use of the agricultural land in the production of food for humans and for livestock. Both criteria can be possible only if the residues of biofuel production, also called byproducts, are used completely.

Grains, such as corn, wheat, barley, and sorghum are the most common inputs for the production of ethanol, and in a smaller amount, it is also included rye, triticale, sorghum, and oats. The process is generally the same for all the grains, although there are some small differences and the characteristics of the products vary somewhat depending on the grain used.

Primarily we use two processes to make ethanol from grains: dry milling and wet milling. In the process of dry milling, typically, the whole grain is pound into flour and processed without separation of the various nutritional components that make up the grain. The flour is moistened with water to form a dough. It is added enzymes to the dough, which is then processed in a drying oven to a high temperature, cooled and transferred to fermenters, where we add yeast and the conversion of sugar to ethanol begins. After fermentation, the “beer” that is produced is transferred to distillation columns where the ethanol is separated from the residual “stillage”.

The stillage is issued by a centrifuge which separates the solids from the liquids. The liquids, or solubles, are then concentrated to a state semi-solid by evaporation, giving condensed distillers solubles (CDS) or “syrup”. Sometimes the CDS will be sold directly into the food market for animals, but more often the residual solids of the coarse-grained and CDS are combined and dried to produce the distiller's dried grains with solubles (DDGS). In cases in which the CDS are not re-added to the residual grains, the product of solid grain is simply called distillers dried grains (DDG). if the distillers grains are supplied to livestock in the proximity of the factory for the production of ethanol the step of dehydration can be avoided and the product is called wet distillers grains (WDG). Due to several practices of dehydrated, and application of syrup, there are some variants of distillers grains (one of which is called modified wet distillers grains), but the majority is sold as DDGS, DDG or WDG.

Some dry milling ethanol plants in the United States currently extract pure corn oil from CDS or from the stillage on the back end of the process using a centrifuge. The corn oil is marketed usually as an individual food ingredient or sold as a feedstock for an additional process (e.g., for biodiesel production). The resulting product from this process is colloquially known as DDGS with “extracted oil” or DDGS “without oil”. Usually these by-products have less fat content than the DDGS conventional ones, but if content slightly higher of protein and other nutrients. A small amount of dry milling plants also have the ability to fully fractionate the grain at the end of the process, obtaining germ, bran, “high protein content “DDGS” and other products. In some cases, the producers of ethanol consider using the portions of the cellulose of the corn bran as a feedstock for cellulosic ethanol. The majority of grain ethanol produced around the world today comes from the dry milling (RFA, 2011; Cooper and Weber, 2012).

In 2010, it was employed globally an estimated of 142.5 million tons of grain for ethanol production, representing 6.3% of the use of grain overall on a gross basis. Because of approximately one-third of the volume of grain processed for ethanol was used to produce food for animals, it is appropriate to suggest that the equivalent of 95 million tons of grain were used to produce fuel oil and equivalent remaining 47.5 million tons entered the food market in the form of by-products. In this way, the production of ethanol represented the 4.2% of the global total use of grain in 2010/11 on a net basis. The United States was the global leader in the production of ethanol from grain, representing 88% of the total grain used for ethanol. The European Union represented the 6% of the grain used for ethanol, followed by China (3.4%) and Canada (2.3%). The vast majority of grain processed for ethanol by the United States was corn, while sorghum represented a small fee (approximately 2%). Initially, the industry of Canada used wheat and corn to ethanol, while the European producers used mainly wheat, but also processed some corn and other coarse grains. Corn also represented the majority of the grain used to produce ethanol in China (Licht, 2011; Cooper and Weber, 2012).

The by-products of biofuels are widely used currently as a nutritional ingredient in the cattle, poultry, and fish diet. They often replace food high price in the rations of animals. It has been indicated that DDGS have resulted in a significant discount to corn and soybean meal, which are the ingredients that substitute primarily in the diets (Hoffman and Baker, 2010). Ruminants, cattle for beef and dairy cows, have historically been the main consumers of feed by-products derived from ethanol and biodiesel. However, the use of these byproducts in the rations of non-ruminants such as pigs and broilers, has increased in the recent years.

The use of byproducts of biofuels has been examined in a good number of studies in rations for animals and have identified key considerations for different animal species. The amount of byproducts that can be added in rations depends on the nutritional characteristics of the individual ingredients and the limiting unique factors to the various species that feed (Shurson and Spiehs, 2002; Anderson et al., 2006; Whitney et al., 2006; Daley, 2007; Klopfenstein et al., 2008; Schingoethe, 2008; Stein, 2008; Bregendahl, 2008; Walker et al., 2011).

In other trials the mass of the traditional inputs displaced from the rations typical for the effect of the inclusion of mass of the byproducts from biofuels has been examined, such as corn distillers grains. In some of these trials it is showed that due to the concentration of certain nutritional components, a given mass of distillers grains may move more than the equivalent mass of corn or soybean meal in some rations. Arora et al. (2008), for example, it was found that 1 kg of distillers grains can displace 1.2 kg of corn in a typical ration of beef. Hoffman and Baker (2011) found that "...in aggregate including major types of livestock/ poultry), one metric ton of DDGS can replace, on average, 1.22 metric tons of food consisting of corn and soybean meal in the United States."

In general, studies show that the distillers grains can reach approximately 30% to 40% in the rations of beef cattle, although it can be used in a higher rate. Studies of animal feeding will usually indicate that the effective inclusion of distillers grains in rates of 20% to 25% for dairy cattle, 20% for pigs from birth to finish, and 10 to 15% for the phases of growth-finishing birds. The gluten from the wet milling is typically the food of beef cattle at an inclusion rate of 30 to 50% of the ration, while the gluten meal is also a common ingredient in pet food. The beet pulp pressed or scratched is typically feed to ruminant animals in no more than 15 to 20% in the diet. The glycerin from the processing of biodiesel can be added to the diets of dairy and beef cattle in small proportions, typically representing not more than 10% of the ration.

The research is trying to determine the inclusion of appropriate levels of glycerine in rations of pigs and poultry (Vander Pol et al., 2006; Flowers and Perry, 2009).

Studies indicate that the production and consumption of meat, milk, eggs, and other agricultural feed may be reduced slightly due to the higher costs of inputs induced by the expansion of biofuels but, it is found that the impacts are small again. For example, U.S. EPA (Environmental Protection Agency) found that the full implementation of the mandates of the RFS consumption of biofuel is expected to cause a reduction in the consumption of only 0.05% of livestock products and 0.03% reduction in the consumption of dairy products by 2022 (EPA, 2010). In an analysis of the impacts to the agricultural market achieved, the mandated RFS of 2015 for biofuels conventional (starch of corn), The United States Department of Agriculture (USDA) found no change in the volume of chicken in The United States, an average of - 0.2% reduction in the volume of milk production and an average reduction of - 0.3% in the volume production of pig on base values between 2007 and 2016 (USDA, 2007).

It indicates that while the results of these economic analyses are instructive, many of the studies have failed to incorporate properly the economic impacts of the consumption increased of the by-products of biofuels by livestock and poultry sectors (Taheripour et al., 2010).

The inclusion of DDGS-corn in the diets of birds is not new; however, the majority of DDGS described in studies of the growth performance and digestibility before the last decade came mostly from the brewing industry; nevertheless, these may be different in chemical composition to the DDGS produced by modern plants producing bioethanol, due to the improved techniques of fermentation. Morrison (1954) noted that it could be included up to 8% of DDGS-corn in the diet practices of broiler without adverse effects on body weight. In another study, it was included up to 25% of DDGS-corn in diets nutritionally adequate of broiler without causing reduction in the body weight or ingestion of food. Additional studies, using DDGS-corn, suggested that up to. 40% of the soybean meal could replace of DDGS-corn, carried out the lysine contents of the diets properly. (Matterson et al., 1966; Waldroup et al., 1981; Parsons y Baker, 1983).

However, there is a general tendency to decrease growth performance, according to the increase of the amount of DDGS in the diet. This may have been due to inefficiency of the birds for obtaining the fiber- the birds have inefficiency in obtaining it. Also, it is knowN that if other nutrients are added, the dose of the raw fiber will increase to almost three by fermentation; this means a high intake of the DDGS could increase the fiber's dietary content, but it would avoid nutrient digestibility of the animals. Thacker and Widyaratne (2007) according to the diet inclusion the chicken broiler, evaluated the composition of the DDGS-wheat considering a portion: 0.5, 10, 15 y 20% so there were considerable differences in weight gain, feed intake, and feed conversion in all treatments according to the control. However, due to the high mortality rate respecting 20% inclusion, it was recommended to incorporate 15% of DDGS-wheat to prevent low energy contents and lysine of DDGS-wheat. This means will be compensated during the formulation of the diet. In addition, Loar et al. (2010) did not obtain differences in the final weight, feed intake and feed change of broilers received 0 or 8 % of DDGS-corn according to the period of starting diets.

Wang et al. (2007a) noted that broilers were fed with 15% of DDGS-corn but the percentage did not differ with the control body weight, and in the food ingestion and feed conversion for 42 days old, however, 30% of inclusion DDGS-corn reduced the food efficiency but any impact on the ingestion of food or weight gain; another study (Wang et al., 2007b) noted that 15% to 20% of DDGS-corn can incorporate in formulating diets of broilers, according to digestible amino acids. in addition, Shim et al. (2011) noted a large increase in the weight during the initial period achieved 24% of DDGS-corn against control.

Lumpkins et al. (2004) recommended an optional inclusion 9% of DDGS-corn and according to the diets of broiler in the first stage was between 12% to 15 % in the stage of growth, because the DDGS-corn overestimated level can influence growth performance. A study reported by Hoskova et al. (2010), in this case they considered 0 or 25% of DDGS-wheat in the diet of the broilers from 12 to 35 days of age; this caused a similar feed intake and feed conversion. But treatment respecting 0% produced a superior growth performance. However, Vilarino et al. (2007), obtained improvement in the feed conversion of broilers because received 10 or 20 % of DDGS-wheat between the first day and ten days of age according to the comparison with the control (0% of DDGS-wheat). The reduction in food ingestion was established in accordance with the level of the DDGS-wheat and especially in the final weight at 37 days of age. Richter et al. (2006) showed reduced in body weight gains and food intake of broiler during the fattening (finishing), according to the level of the DDGS-wheat that increase to 20% in the diet, Lukasiewicz et al. (2009) determined improvements in the feed conversion of broilers able to receive 7, 9.5 y 9.5% of DDGS-wheat during the first days, growth and fattening (finishing). However, increasing body weight was higher in the control groups as also in males and females receiving DDGS-wheat

Also, they distinguished that the inclusion of DDGS-wheat in the diet of the broilers increases according to number of beneficial microorganisms in the intestine (there was a decline in the caecal population of enterobacteriaceae).

Extensive feeding tests carried out by Noll et al. (2002, 2003 a, b), they were reviewing the different possibilities of using DDGS-wheat in bucks considering grow-finish diets/ fattening turkeys, whereas, the diet was derived on basis of the digestible amino acid composition. According to studies there were no differences found in the total weight of catch and feed conversion representing 10% inclusion rate of DDGS-corn. In another research, the proportions are in accordance with 15 and 20% of DDGS-corn reached a similar to the control group (Noll et al., 2004); however, the average of the inclusion was 20% this means that decreased the final body weight during at 19 weeks of age according to subsequent studies by the same authors (Noll et al., 2005).This following research, established by Noll et al. (2009) showed that body weight reached a greater growth during 5 weeks of age in turkeys. In this case the diet consists 10, 20 and 30% of DDGS-corn a difference between another did not include during the diet.

This is due exogenous enzymes in poultry diets that can aid growth and fattening (finishing), also the efficiency of nutrient according to use of nutrients and excretion of nutrients, based on the research, some authors have evaluated the different benefits in poultry diets containing DDGS. Slominski

(2010) found that performance increased of broiler. The food intake combined with DDGS-corn and DDSGS-wheat with or without enzyme supplementation. In this case sowed 10% between DDGS-wheat/corn establishing a similar balance in the control diet. (0% DDGS) that between in the absence of enzyme and presence of the enzyme was achieved according to the control 15% of DDGS. The following research by Olukosi et al. (2010) the average of inclusion was 10% of DDGS-corn in the diet of broiler supplemented with a mixture of enzymatic action phytase, xylanase, amylase and protease produced a better gain in body weight, food intake and food efficiency at three weeks of age, were compared with diets without DDGS-corn or supplemental enzymes.

According to studies of PNA, some researchers have studied the effect of processing techniques with the purpose of reducing the level of PNA. Due to the anti-nutritional effect of PNA in DDGS. Oryschak et al. (2010) examined the use of DDGS-corn and DDGS-wheat (physical breakdown of the cell wall and reduction in the molecular weight of the substrate) and not extruded between 0 to 30% in the diet of broilers. The authors recommended an inclusion rate of no more than 10% DDGS.-corn or DDGS-wheat with or are extruded because above this proportion the yields responses tended to decrease. In addition to knowing the inclusion rates in the DDGS-corn or DDGS-wheat, also allowed to know the balance that may exist between the different performance studies.According to the results, the different nutritional qualities corresponds to use of DDGS would vary in the yield, and among them are the chemical characteristics such as the race, age of the bird, and finally the conditions established in which it can affect the performance. However, there is a possibility that a diet containing DDGS that is balanced using digestible nutrient values will support performance and additional benefits may results by supplementation with exogenous enzymes (Adebiyi, 2014).

Method

In this research process developed in the field phase collecting the data carries out in poultry breeding. This research was carried out in Lambayeque, located at the eastern side of the city, district, province and region of the same name. The duration of this process was 42 days.

The following treatments were evaluated: T1:

W1: witness

W2: 5% of DDGS in the diet;

W3: 10% of DDGS in the diet;

W4: 15% of DDGS in the diet.

There were used 100 broilers COBB500 of only one day old. Both sexes have remained in an incubator located in the city of Trujillo.

The chicks were homogeneous in the initial weight and were in good health. Also similar rations were prepared to facilitate the supply of energy and protein according to the treatments. In this feeding program required two rations that consist: during the first phase (until the 21 days of old-Table 1) the second phase growth- finished (between 21 and 42 days of old , Table 2)

Table 1

Percentage composition of the ration, during the first phase.

Input	Treatments T_1	T_2	T_3	T_4
DDGS	00.00	05.00	10.00	15.00
Corn	60.00	57.00	56.00	54.00
Soy cake	29.94	27.94	23.94	20.94
Fish flour	03.00	03.00	03.00	03.00
Wheat bran	01.00	01.00	01.00	01.00
Soy oil	02.00	02.00	02.00	02.00
Carbonate de CaC03	01.93	01.93	01.93	01.93
Common salt	00.18	00.18	00.18	00.18
Choline chloride	00.20	00.20	00.20	00.20
Bicarbonate	00.05	00.05	00.05	00.05
Pre-mixed	00.10	00.10	00.10	00.10
Phosphate-calcium	01.15	01.15	01.15	01.15
Mold Zapp	00.05	0.05	0.05	0.05
Bio-Mos	00.10	00.10	00.10	00.10
DL-Methionine	00.19	00.19	00.19	00.19
Coccidiostat	00.05	00.05	00.05	00.05
Allzyme SSF	00.06	00.06	00.06	00.06
Note: estimated contribution:				
Protein , %	19.7	19.5	19.6	19.5
Energy Met., Mcal	3.1	3.2	3.2	3.2

Table 2

Percentage Composition of the rations during the growth phase

Input	Treatments T1	T2	T3	T4
DDGS	00.00	05.00	10.00	15.00
Corn	61.00	58.00	55.00	52.00
Soy cake	31.92	29.92	27.92	25.92
Wheat bran	01.00	01.00	01.00	01.00
Soy oil	03.00	03.00	03.00	03.00
Carbonate CaC03	01.42	01.42	01.42	01.42
Common salt	00.18	00.18	00.18	00.18
Choline chloride	00.15	00.15	00.15	00.15
Bicarbonate	00.05	00.05	00.05	00.05
Pre-mixed	00.10	00.10	00.10	00.10
Phosphate-calcium	00.52	00.52	00.52	00.52
Mold Zapp	00.05	00.05	00.05	00.05
Bio Mos	00.10	00.10	00.10	00.10
DL-Methionine	00.05	00.05	00.05	00.05
Coccidiostat	00.05	00.05	00.05	00.05
Allzyme SSF	00.06	00.06	00.06	00.06
Toxibond	00.25	00.25	00.25	00.25
Lysine	00.10	00.10	00.10	00.10
Estimated contribution:				
Protein, %	18.7	19.0	19.3	19.3
Energy Met., Mcal	3.3	3.3	3.3	3.3

The DDGS-corn is an evaluated product it was purchased from a local supplier and marketed throughout the region for breeders and producers of different animal species, in this case dairy cattle and birds.

It is a product imported from the United States of America and brought to Peru by maritime transport.

According to installations and equipment that were used: barnyards from 3m^2. Made with cardboard, wood, wire, thatched, as the bedding material, feed hoppers, siphon drinking troughs, plastic tapes, indelible ink maker, stapler, field book, camera, electronic balance, weighing approximately 1g; weighing scale, in addition to equipment used for poultry farming.

In order to test the hypothesis were used totally random design, described in accordance to the following linear additive model.

$Yij = \mu + \tau i + \xi ij$

It achieved just 5%of the maximum probability of making a Type 1 error.

The installations have been cleaned and disinfected one week before the arrival of the chickens. Also, the equipment and blankets in this case with an anticipation of 20 days. And before the arrival of the chickens the toilet was emptied, the bed material (rice husk) was extended and iodine water applied.

Each of the chicks were randomly assigned to each of the treatments, identified the initial weighing; and every 14 days the chickens were weighed. The randomization involved considering the distribution as homogeneous as possible, of the males and female between the groups; and to differentiate between both was considered the length of the feathers of the left wing. During the first 14 days of days the chicks were exposed to a heat sources for a conventional power plant.

The supplies to prepare the rations were purchased from a supplier located in the national wholesale market in the city of Lima. The rations were prepared on the floor, but previously cleaned and disinfected. In this way the mixing process was progressive to ensure the homogeneity of the mixture. The inputs that were first combined were those that were in proportions lower than 1% respecting the diet, after achieving homogenization they were combined with a fraction of the corn, and then progressively the rest of the corn and other was added. The oil used was combined with a portion of corn and then mixed with the previous mixture. The food was supplied in quantities for ad libitum consumption;this mean to determinate the differences between the quantities offered and the waste.

After poultry farming, a sample of each treatment was sacrificed to determine carcass weight and yield; the chicken carcass didn’t include tarsi, neck, head, liver and gizzard. In this period of 12 hours of food withdrawal was considered; in the sacrifice, a stunning (dorsal rope break), and grave, bleeding depending case blanching (70ºC); in this case the manual process requires plucking and evisceration. The head-neck, gizzard, liver and tarsi were separated and after weight were recorded.

for this reason, the corresponding sanitary measures were carried out (include a disinfectant footbath, regular fumigation, prohibited entry to person adverse to the experiment.,fly control measure , etc); to avoid the health and hygiene problemas.

For this reason, it is considered to evaluate the following variables.

-Feed intake

-Total weight and live-weigh increase

-Food conversion

-Economic merit

-Based on body weight and carcass.

The feed conversion was determined in the traditional form (food consumed per kg/

Live weight increased per kg).

The economic merit is considering by the amount of money spent on food to increase one kg of live weight. The carcass yield expresses the percentage between the weight of the carcass and the live weight immediately before slaughter.

In the statistical analysis, it was considered:

The purpose of corroborating homoscedasticity requirement to apply the analysis of the variance, proceed to apply the homogeneity test of variances, the initial weight and the weight increments, (scheffler, 1982).

The analysis of the variance about the increments of weight, and accordance the cases the value F was significant because he proceeded to apply Duncan's multiple-stroke test. When the increase in weight was analyzed at 14 and 28 days of age, it was determined that the value of $\chi 2$ of the Bartlett test was significant and showed that for these ages the condition of homoscedasticity, for this motive, the logarithmic information was transformed and applied the analysis of the variance, a recommendation that is suggested by Oestle (1979).

In this case the information was used a percentage form, (carcass yield) this means the square root-arcsine transformation was applied, with the objective to normalize the information according to its nature representing (kurtosis) towards one of the sides of the normal distribution curve (scheffler, 1982)

Results and discussion

The results obtained in table Nº 3 are based in the consumption of food

Table 3

Food consumption of broilers received DDGS-corn in the food in the progressive form.

	Treatments			
	1	2	3	4
Chickens /treatments	25	25	25	25
Duration, days	42	42	42	42
DDGS, maize %	00	05	10	15
Consumption per kilogram of chicken				
Starting	0.542	0.548	0.560	0.570
Growth	1.476	1.528	1.533	1.5466
Finished	2.124	2.262	2.260	2.308
Accumulated	4.142	4.338	4.353	4.424

According to observation of the figure, all the treatments based on DDGS-corn showed consumption superior to the witness; according to the treatment, it was possible to notice the greater consumption between which were increasing.

In figure 1, the percentage has shown the comparison between the accumulated consumption.Although the effect on consumption was not very large, it was consistent because it could be sustained according to the DDGS-corn content. This means that as the content increases also will increase the ration of consumption.The highest cumulative consumption representing 4.7, 5.1 and 6.8% according to treatments 2 and 4 based on the control.

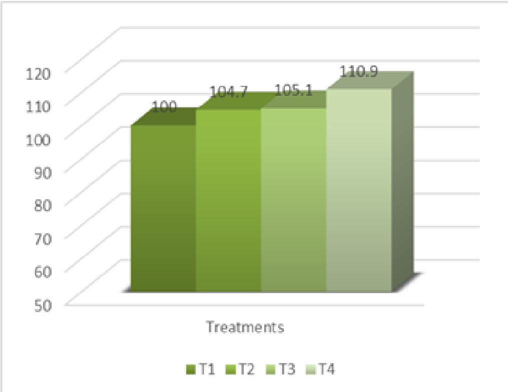

Figure 1, based on a comparative analysis of treatments for cumulative food consumption.

According to different researches, the DDGS-corn and DDGS-wheat will be evaluated and analysis by the different proportions (about 20%) that do not correspond to the important effects on food consumption (Parsons y Baker, 1983); and the contribution of energy in the diet it would motivate the animal to consume more in order to compensate for the lower energy content. In the project, the feed intake is the first indicator evaluated due to the function depends on the adequate or inadequate performance. However, it would not make sense that the food has adequate chemical elements if it is not consumed. The results show that many of them have obtained with consumption, indicates that the input is adequate. The final results are relational with the weight and gains in live weight according to the Table 4.

Table 4

Living weight and its increase of broiler chickens that were fed with DDGS-corn progressively.

Aspects	Treatments			
	1	2	3	4
Chickens /treatments	25	25	25	25
Duration /days	42	42	42	42
DDGS-corn %	0	5	10	15
Weight, grams per chicken:				
Initial	42.84	43.64	43.48	41.96
14 days	349.04	366.84	351.48	345.96
28 days	1274.2	1315	1345.6	1258.7
42 days	2308.4	2268.7	2323.6	2224.1
Weight increase, grams /chickens				
Initial	306.2	323.2	308	304
Increase	925.2	948.2	994.1	912.7
Finished	1034.2	953.7	978	965.7
Accumulated	2265.6	2225.1	2280.1	2182

a, b different letter according to averages, indicate considerable differences ($P \leq 0.05$, Duncan) between the treatments of breeding periods.

These gains in weight in the "initial" period, Bartlett's test of variance homogeneity made it possible to resolve the individual components of variances, and uniformly distributed among the treatments; including the analysis of variance showed differences did not reach statistical significance. According to the percentage comparison showed that treatment 2 representing 5.6% above the control; this treatment was very close of control, respecting 0.6% above it; and finally, the treatment 4 shown below 0.7%

In the "growth" period, according to the test of variance homogeneity indicated the absence homoscedasticity; in this case the logarithmic information was transformed to be able to implement the analysis of the variance that showed the differences reached statistical significance; and treatment 3 showed the best increase achieved. The percentage comparison was carried out in the treatment 2 and 3 outweigh to the control 2.5 and 7.5%; while treatment 4 sowed to be below 1.3% of control.

In the "finished" period, in concordance the test of variance homogeneity showed that there is homoscedasticity and after we proceeded to apply the analysis of variance, about the statistical significance ($P \leq 0.05$) carried out by the different of the treatments, showed that the control treatment was superior between the three treatments that can include in the diet DDG-corn.

According to the percentage comparison carried out by different treatments 2, 3 and 4 were below the control that representing 7, 8, 5.4 and 6.7%; treatment 3 (10% of DDGS-corn en the diet) showed less decrease.

Assessing the accumulated increase in weight, the variance homogeneity test determined the residual components of variances were distributed on the treatments; when applying the analysis of variance, it was shown that the differences between did not reach statistical significance.

The percentage comparison showed the treatment 2 representing 1.8% below the control, treatment 3 achievement 0.6% above, and finally representing 3.7 % below. This behavior shown that the DDGS-corn can incorporate in the diet in accordance 10%, this means that the greater inclusion has a tendency considerable decrease in the yield, when the difference with the control was not significant.

The analysis of covariance between the accumulative increase according to weight and initial weight shown that was not significant the effect of the concomitant variable. The analysis of covariance between the accumulate increase and the initial weight determined what little significant during the effect of the concomitant variable.

In this case, the project shown that the weight increases and were better achievement 5% in the initial, 10% in the growth without DDGS in the finished. If only the accumulated weight increase was considering, it can be observed that 10% of DDGS the also achieves the same biological efficiency as with the control.

Between to the different researchers; however, in this statistical analysis doesn't show significant differences between the control and treatment respecting 15% of DDGS in the diet, the different that exist between these treatments was 3.7% according with the control, based on conditions that difference will also be of considerable economic importance.

The protein content that show relatively high (27 to 29.8% of PC; 20.5 a 23.2 MJ/ kg) make it possible to technically support the inclusion of DDGS-corn in the diet of chickens. However, it is difficult to explain why chickens didn't behave better than the control in the finishing phase. Richer at al. (2006) and Hoskova et al. (2010) obtained better yields of control in finishing. This means that during the period an interaction between the nutrients due to the considerable higher feed consumption of chickens, in which the fiber can be an important role. This appreciation is reinforced according to results obtained by Shime et al. (2011) representing 24% of DDGS-corn in the initial diet obtained better results than the witness

The results of food conversion and economic merit are shown in Table 5.

Table 5

Food conversion and economic merit of chickens-meat received DDGS-corn in the feed in a progressive way.

	TREATMENTS	
ASPECTS	**1**	**2**
Chickens /treatments	25	25
Duration, days	42	42
DDGS, corn %	00	05
Feed conversion:		
Starting	1.77	1.7
Growth	1.6	1.61
Finished	2.05	2.37
Accumulated	1.83	1.95
Food expenditure:	1.972	196.3
Economic merit	3.48	3.69

At the "initial", the conversion achieved by treatment 2 (5% de DDGS-corn) register 3.9% more efficient than that achieved by the control; according to the treatments 3 and 4 (10 and 15% de DDGS-corn) represented 2.8 and 6.2% less efficient than that of the witness.

In this way agrees with the opinion of different researchers (Zijlstra et al., 1999; Boros et al., 2002; Carre et al., 2002; Bedford et al., 2004; Choc et al., 2004; Zijlstra et al., 2007; Adeola and Cowielson, 2011) this depends on the to increase above a certain proportion, this means that the presence of DDGS in the diet reduces the efficiency of the feed conversion due to increase of fiber, which is not only composed of cellulose and hemicelluloses, but also by arabinoxylans and Beta-glucans and other fractions of arabinogalactans, galactans and pectic polysaccharides.

The arabinoxylans and and Beta-glucans are highly soluble in water and the digestive and nutrient absorption process in the TGI are involved when ingested in excessive amounts.Soluble non-starch polysaccharides (PSN) soluble in water carried out the antinutritional properties due to their high affinity to water and the formation of gel-like substances.

The formation of the gel produces an increase in the viscosity of the digesta, slower transit rate of the digesta in the TGI, also a reduction in the absorption of nutrients by encapsulation of the nutrients and enzymes within the gel medium. These effects have negative consequences on the use of energy and nutrients.

According to the same order of treatments, the "growth", in the treatments 3 (10% de DDGS) that conversion represented 3.7% more efficient than that of the control; in treatments 2 and 4 (5 and 15% respecting of DDGS) in this case the conversion was less efficient achieved 0.6 and 5.6%.

The increasing in age improves with the supportability of chicken is according to the highest proportion of DDGS. However, according to the weight increase, in base the finish all treatments that received the product show less efficient than the control in concordance the use of the food to gain weight and it is necessary into account that all the diets that were delivered between 22 and 42 days of age received an enzyme supplement and lysine, the enzyme supplement was also supplied in the diet provided between days 1 and 21 in all treatments.

Several researchers (Cromwell et al., 1993; Spiehs et al., 2002; Fastinger et al., 2006; Vilarino et al., 2007; Cozannet et al., 2011) have indicated that a series of factors can present that act in a negative way, reducing DDGS as food; in this case the balance of amino acids, mainly lysine. Depending on the period the chickens can gain one kg or more of live-weight but also depends on quantify of lysine supplement to achieve better efficiency in the use of the feed in the "finished" period.

Lysine could be diminished because the product received excessive heat treatment. According to excessive heat treatment of DDGS can cause the amino group of the lysine to react with the carbonyl group on the reducing sugars in a Maillard reaction. This reaction are mainly due the birds don't have the enzymes capable of breaking the ligation between the lysine and the sugar residue, then the product of the reaction is not available, generally, for hydrolysis in the gastrointestinal tract is excreted. However, one would expect the amount of free sugar in DDGS to be lower, because fermentation would change them to alcohol. However, the reduction in sugars cannot reduce the potential for Maillard reactions; this means that the amount of free amino acids in increases with fermentation (CromwelL et al., 1993; Nyachoti et al., 2005; Noll et al., 2007a; Vilarino et al., 2007; Kingsly et al., 2010; Liu, 2011).

In this case could also assume the "finish" as the inadequate way of ingesting minerals, especially phosphorus due to the peculiarity of having an important part of the phytic acid. (Martínez-Amezcua et al., 2004; Martínez-Amezcua y Parsons, 2007; Steiner et al., 2007; Widyaratne y Zijlstra, 2007; Szczurek, 2009; Liu y Han, 2011); however, this option you are no longer required to enzyme supplement with phytase action is included in the food.

According to cumulative value of feed conversion it could noted that the treatment that most closely approached the control was which included 10% of DDGS, achieved 5% in the treatment of DDGS and the other not so close (less efficient achieved 10.9%). Was the treatment that representing 15%; as can show in figure Nº 2, carried out the efficiency of use of the feed to gain live weight, achieved 10% of DDGS-corn in the diet of broilers.

But it would be advisable to implement a plan in which 5% during in the start, 10% in the growth and not to use it in finish. However, it is necessary to take into account another variable such as economic merit.

When we considering the economic merit, the percentage comparison it is comparative between treatments 3 (10% of DDGS) representing 1.1% more efficient than the control and the treatment 2 and 4 (5 and 15% of DDGS) achieved less economically efficient 6 and 2%. These results corroborate the recommendation to use 10% of DDGS in the diet, and according to the economic margin this treatment is due to the fact the inclusion of DDGS allows replacing a more expensive input (soya cake), but the difference is the price per kg based 0.76 nuevos soles in accordance if **DDGS**.

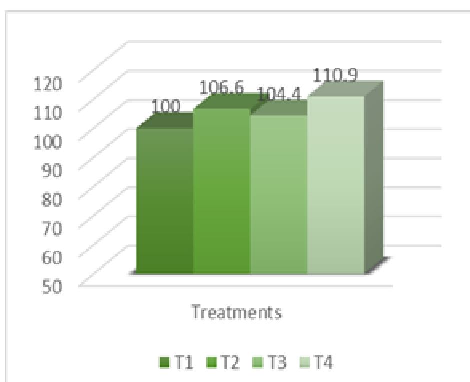

Figure 2.

The product evaluated (corn DDGS) shows a positive potential if entering in the rations of broilers, based on its technical and economical live-performance. Despite the fact that oil prices have declined to their minimum in the international market, which would lead to a decrease of ethanol and biodiesel production, this decrease may not be sustained for a long time.

Furthermore, it is a fact that oil is being used up in the world and consequently, human beings will be forced to use alternative fuels including ethanol and biodiesel. Moreover, we will have to use the by-products of this industry and using it as food supply seems to be not only a good but the best option.

Table 6 shows the results of weight and yield of carcass.

Table 6

Carcass weight and yield of broilers fed with corn DDGS, progressively.

ASPECTS	TREATMENTS			
	1	2	3	4
Chickens /treatments	25	25	25	25
Duration, days	42	42	42	42
DDGS, corn %	0	5	10	15
Carcass weight	1695	1732	1839	1936
Percentage comparative:				
	100	102.2	114.3	113.8
Carcass output %:				
	73.85	75.37	81.85	83.9

Regarding to the carcass weight, the analysis of variance showed that the differences between treatments were significant. Treatments 3 and 4 were similar to each other and higher than treatments 1 and 2. When performing the comparative percentage, it was observed that all the treatments which included corn DDGS were higher than the witness; thus, treatments 2, 3 and 4 were superior in 2.2, 14.3 and 13.9%, respectively.

With the yield of carcass, differences between treatments reached statistical significance. For instance in carcass weight: treatments 3 and 4 were similar to each other and higher than treatments 1 and 2, which did not differ between them neither. Corn DDGS as a product is defined as what is left after the most carbohydrates of the corn in the form of alcohol (ethanol) have been removed, allowing it to greatly increase the proportion of proteins and lipids. On the other hand, fermentation process is carried out by Saccharomyces cerevisiae and, apparently, allows components of this yeast to be present in the product. Moreover, the tenor and composition of the protein exhibited have been modified towards a better aminogram.

Ingledew (1999) reported that yeast may constitute up to 5.3% of the total protein in corn DDGS. On the other hand, Belyea et al. (2004) noticed that yeast protein contributes approximately 55% to the total content of protein in corn DDGS. However, the value reported by Belyea et al., has apparently overestimated the contribution of yeast protein to the total protein in DDGS because the researchers did not quantified for amino acids necessary in the estimation. Martinez-Amezcua (2005) reported that approximately 10% of the total amino acids in corn DDGS is contributed by the yeast. Belyea et al. (2004) also argued that the lysine amino acid found in low concentrations in corn grain (0.24 g/ 100g) and in much higher concentrations in yeast (3.32 g/ 100 g) increased in corn DDGS (0.77 g/ 100 g). According to Liu (2011), amino acids concentrations in the post-fermentation of corn change: there was a fast increase of some, there was not an alteration of some others and in some cases it decreased.

In some way, this may cause corn DDGS to replace soybean cake and principles contributed by the yeast to stimulate the metabolism to anabolic- type functions, as has been shown in different trials. These show the components of the yeast wall, such as are prebiotics, mycotoxins and, above all, providers of nucleotides and nucleosides that promotes the functions of synthesis of tissues due to their participation by improving the availability of useful energy, as components of coenzymes, physiological regulators, such as carriers of activated intermediates, improving the synthesis of proteins, mitosis, cell, optimizing the metabolism of lipids, leading to better activity hematological, intestinal morphology, and liver tissue (Berne et al., 1983; Gil et al., 1985; Sánchez-Pozo et al., 1985; Delucci et al., 1987; Uauy et al., 1990; Scopesi et al., 1999; Cory, 1992; Mosqueda-Garcia, 1993; Good et al., 1994; Carver, 1994; Ortega et al., 1994; Sanderson and He, 1994; Carver and Walker, 1995; Matsumoto et al., 1995; Voet and Voet, 1995; Lopez et al., 1996, 1997; Nishizawa et al., 1996; Iwasa et al., 1997; Kishibuchi et al., 1997; Yamamoto et al., 1997; Yamauchi et al., 1998; Tsujinaka et al., 1999; Stryer et al., 2013).

Results obtained with the weights and yields of carcass show that the DDGS-corn constitute a good alternative in the feeding of the chicken meat at least until the proportion of 15% in the diet.

The problem that could occur to your suitable employment would be the quality of the product that reaches our country, as has been indicated in the bibliography that the quality could be adversely affected by several factors in the process of production and storage.

Conclusions

It was showed a definite tendency to increase the consumption of food as it increased the proportion of corn DDGS in the diet; in 4.7, 5.1, and 6.8% in the accumulated consumption in the treatments with 5, 10 and 15% of the product, respectively, on the witness.

The weight increments accumulated were similar to those of the witness with 10% of DDGS-corn in the diet; it was noted that in the beginning it was better with 5% growth with 10% of the product, in the finish all treatments with DDGS - corn were below the witness.

In the beginning, the best feed conversion was 5% growth and 10%, the finish was better with the witness; the conversion of food accumulated that more is approached to the witness was with 10% of DDGS-corn.

It was achieved a better economical position with 10% of corn - DDGS, surpassing the witness at 1.1%; this was due to the price differential to replace part of the cake of soybean.

The weight and yield of carcass was significantly higher with 10 and 15% of corn-DDGS , surpassing the witness at 14% in weight and 10 percentage units in the performance.

Bibliographic references

Adebiyi, A. O. 2014. The nutritional value for poultry and pigs of biofuel co-products. PhD thesis. University of Glasgow. Scotland, United Kingdom.

Adeola, O. and A. J. Cowieson. 2011. Opportunities and challenges in using exogenous enzymes to improve non ruminant animal production: BOARDINVITED REVIEW. Journal of Animal Science, 89:3189-3218.

Anderson, J., D. Schingoethe, K. Kalscheur, and A. Hippen. 2006. Evaluation of dried and wet distillers grains included at two concentrations in the diets of lactating dairy cows. Journal of Dairy Science, 89: 3133–3142.

Arora, S., M. Wu, and M. Wang. 2008. Update of distillers grains displacement ratios for corn ethanol life-cycle analysis. Center for Transportation Research, Energy System Division, Argonne National Laboratory. Chicago, Illinois, USA.

Bedford, M. R. 2000. Exogenous enzymes in monogastric nutrition--their current value and future benefits 1. Animal Feed Science and Technology, 86:1-13.

Belyea, R. L., K. D. RAUSCH, and M. E. TUMBLESON. 2004. Composition of corn and distillers dried grains with solubles in grind ethanol processing. Bioresource Technology, 94:293-298.

Berne, R. M., R. M. Knabb, S. W. Ely, and R. Rubio. 1983. Adenosine in the local regulation of blood flow: a brief overview. Federation Proc., 42:3136-3142.

Boros, D., R. R. Marquardt, W. Guenter, and J. Brufau. 2002. Chick adaptation to diets based on milling fractions of rye varying in arabinoxylans content. Animal Feed Science Technology, 101: 135-149.

Bregendahl, K. 2008. Use of distillers co-products in diets fed to poultry. Chapter 5, in: B.A. Babcock, D.J. Hayes and J.D. Lawrence (editors). Using Distillers Grains in the U.S. and International Livestock and Poultry Industries. Midwest Agribusiness Trade Research and Information Center.

Bueno, J., M. Torres, A. Almendros, R. Carmona, M. C. Núñez, A. Rios, and A. Gil. 1994. Effect of dietary nucleotides on small intestinal repair after diarrhoea. Histological and ultrastructural changes. Gut, 35:926–933.

Carre, B., A. Idi, S. Maisonnier, J. P. Melcion, F. X. Oury, J. Gomez, and P. Pluchard. 2002. Relationship between digestibilities of food components and characteristics of wheats (*Triticum aestivum*) introduced as the only cereal source in broiler chicken diet. British Poultry Science, 43: 404-415.

Carver, J. D. 1994. Dietary nucleotides: cellular immune, intestinal and hepatic system effects. J. Nutr., 12:144-148.

Carver, J. D., and W. A. Walker. 1995. The role of nucleotides in human nutrition. Nutr. Biochem., 6:58-72.

Choct, M., A. Kocher, D. L. E. Waters, D. Pettersson, and G. Ross. 2004. A comparison of three xylanases on the nutritive value of two wheats for broiler chickens. British Journal of Nutrition, 92:53-61.

Cooper, G. and A. Weber. 2012. An Outlook on world biofuel production and its implication for the animal feed industry. In: Biofuel CoProducts as Livestock Feed: Opportunities and Challenges. (MAKKAR, H.P.S., ed.) FAO. Rome, Italy. pp. 1-12.

Cory, J. G. 1992. Purine and pyrimidine nucleotide metabolism. Pages 529-571 in Textbook of Biochemistry. T. M. Devlin, ed. Wiley-Liss, Inc., New York, NY.

Cozannet, P., Y. Primot, C. Gady, J. P. Metayer, M. Lessire, F. Skiba, and J. Noblet.

2011. Standardised amino acid digestibility of wheat distillers' dried grains with solubles in force-fed cockerels. British Poultry Science, 52:72-81.

Cromwell, G. L., K. L. Herkelman, and T. S. Stahly. 1993. Physical, Chemical, and Nutritional characteristics of distillers dried grains with solubles for chicks and pigs. Journal of Animal Science, 71:679-686.

Daley, E. 2007. Impact of ethanol expansion on the cattle feeding industry. MSc Thesis. Texas A&M University, College Station, Texas, USA.

-De Lucchi, C., M. L. Pita, N. J. Faus, J. A. Molina, R. Uauy, and A. Gil. 1987. Effect of dietary nucleotides on fatty acid composition of erythrocyte membrane lipids in term infants. J. Pediatr. Gastroenterol. Nutri., 6:568-574.

EPA [United States Environmental Protection Agency]. 2010. Renewable Fuel Standard Program (RFS2) Regulatory Impact Analysis. Washington, D.C., USA. 901 p.

Fastinger, N. D., J. D. Latshaw, and D. C. Mahan. 2006. Amino acid availability and true metabolizable energy content of corn distillers dried grains with solubles in adult cecectomized roosters. Poultry Science, 85:1212.

Flores, A. and A. Perry. 2009. Biodiesel with benefits: Fuel for cars and leftovers for livestock. Agricultural Research Service. U.S. Department of Agriculture, Washington, D.C., USA.

FAO (Food and Agriculture Organization). 2012. Biofuel Co-Products as Livestock Feed: Opportunities and Challenges. H. P. S. Makkar (editor). United Nations Organization. Rome, Italy. 553 pp.

Gil, A., M. L. Pita, J. Martinez, J. A. Molina, and F. Sánchez-Medina. 1985. Effect of dietary nucleotides on the plasma fatty acids in atterm neonates. Hum. Nutr. Clin. Nutr., 40:185-195.

Hoffman, L. and A. Baker. 2010. Market issues and prospects for U.S. distillers' grains: supply, use, and price relationships. USDA, Hoffman, L. and A. Baker. 2010. Market issues and prospects for U.S. distillers' grains: supply, use, and price relationships. USDA,Economic Research Service, Washington, D.C., USA. 2 p.

Hoffman, L. and A. Baker. 2011. Estimating the substitution of distillers' grains for corn and soybean meal in the U.S. feed complex. USDA, Economic Research Service, Washington, D.C., USA. 1 p.

Hoskova, S., A. Vasatkova, P. Kratochvilova, M. Balabanova, M. Lichovnikova, and L. Zerman. 2010. The influence of distillers dried grains with solubles in broilers feed mixtures on their growth parameters. Acta Universitatis Agriculturae et Silviculturae Mendelianae Brunensis, 58:179-184.

Ingledew, W. M. 1999. Yeast- could you base a business on this bug? In Biotechnology in the Feed Industry; Proceedings of Alltechs 15th Annual Symposium. Nottingham University Press: Nottingham, U.K. pp 27- 47.

Iwasa, Y., M. Iwasa, Y. Omori, T. Toki, A. Yamamoto, H. Maeda, M. Kume, and S.Ogoshi. 1997. The well-balanced nucleoside-nucleotide mixture "OG-VI" for special medical purposes. Nutr., 13:361- 364.

Kingsly, A. R. P., K. E. Ileleji, C. L. Clementson, A. García, D. E. Maier, R. L. Stroshine, and S. Radcliff. 2010. The effect of process variables during drying on the physical and chemical characteristics of corn dried distiller's grains with solubles (DDGS) - Plant scale experiments. Bioresource Technology, 101:193-199.

Kishibuchi, M., T. Tsujinaka, M. Yano, T. Morimoto, S. Iijima, A. Ogawa, H. Shiozaki, and M. Monden. 1997. Effects of nucleoside and a nucleotide mixture on gut mucosal barrier function on parenteral nutrition in rats. J. Parenter. Enterol. Nutr., 21:104-111.

Klopfenstein, T. J., G. E. Erickson, and V. R. Bremer. 2008. Use of distillers co-products in diets fed to beef cattle. Chapter 2, in: B.A. Babcock, D.J. Hayes and J.D. Lawrence (editors). Using Distillers Grains in the U.S. and International Livestock and Poultry Industries. Midwest Agribusiness Trade Research and Information Center. USA.

Licht, F. O. 2011. Feedstock use for biofuels – The outlook for 2011. World Ethanol & Biofuels Report, 9(17): 1.

Liu, K. 2011. Chemical composition of distillers grains, a review. Journal Agricultural Food Chemistry, 59:1508-1526.

Liu, K. and J. Han. 2011. Changes in mineral concentrations and phosphorus profile during dry-grind processing of corn into ethanol. Bioresource Technology, 102: 3110–3118.

Loar, R. E., J. S. Moritz, J. R. Donaldson, and A. Corzo. 2010. Effects of feeding distillers dried grains with solubles to broilers from 0 to 28 days posthatch on broiler performance, feed manufacturing efficiency, and selected intestinal characteristics. Poultry Science, 89:2242-2250.

López, N. A. T., J. D. Bueno, A. Gil, and A. P. Sánchez. 1996. Morphological changes in hepatocytes of rats deprived of dietary nucleotides. British J. Nutr., 76:579-589.

López, N. A., A. Gil, and A. P. Sánchez. 1997. Age related effect of dietary nucleotides on liver nucleic acid content in rats. Annal. Nutr. Metab., 41:324-330.

Lukasiewicz, M., M. Michalczuk, J. Gajewska, K. Wilczynska-Czyz, and J. Niemiec. 2009. Wheat distilled dried grains with solubles (DDGS) as a replacer of extraction soil meal in nutrition of broiler. Annals of Warsaw University of Life Sciences: Animal Science, 46: 315-321.

Lumpkins, B. S., A. B. Batal, and N. M. Dale. 2004. Evaluation of distillers dried grains with solubles as a feed ingredient for broilers. Poultry Science, 83:1891.

Martínez-Amezcua, C. 2005. Nutritional evaluation of corn distillers dried grains with solubles (DDGS) for poultry. PhD Dissertation. University of Illinois-Urbana Champaign, Urbana, IL.

Martínez-Amezcua, C., C. M. Parsons, and S. L. Noll. 2004. Content and relative bioavailability of phosphorus in distillers dried grains with solubles in chicks. Poultry Science, 83:971.

Martínez-Amezcua, C. and C. M. Parsons. 2007. Effect of increased heat processing and particle size on phosphorus bioavailability in corn distillers dried grains with solubles. Poultry Science, 86: 331-337

Matsumoto, Y., A. A. Adje, K. Yamauchi, M. Kise, Y. Nakasone, Y. Shinegawa, H. Yokoyama, and S. Yamamoto. 1995. Mixture of nucleosides and nucleotides increases bone marrow cell and peripheral neutrophil number in mice infected with methicillinresistant Staphylococcus aureus. Biochemical and molecular roles of nutrients. J. Nutr., 125:815-822.

Matterson, L.D., J. Tlustohowicz, and E.P. Singsen. 1966. Corn Distillers Dried Grains with Solubles in Rations for High-Producing Hens. Poultry Science, 45:147–151.

Morrison, F. B. 1954. Feeds and Feeding: A Handbook for the Student and Stockman. 21st edition. The Morrison Publishing Company. Ithaca, NY, USA.

Mosqueda-García, R. 1992. Adenosine as a therapeutic agent. Clin. Invest. Med., 15:445-455.

Nishizawa, N., Y. Harada, and M. Fujimoto. 1996. Effect of dietary nucleotides on cholesterol metabolism in mice. Page 15 in Proc. 70th Annual Meeting of Japan Society for Bioscience, Biotechnology, and Agrochemistry. Tokyo, Japan. (Abstr.)

Noll, S. L., C. Abe, and J. Brannon. 2003a. Nutrient composition of corn distiller dried grains with solubles. Poultry Science, 82:71.

Noll, S. L., C. Parsons, and W. Dozier III. 2007b. Formulating Poultry Diets with DDGS – How Far Can We Go? In: Proceedings of the 5th Mid-Atlantic Nutrition Conference,

N.G. Zimmerman, ed. College Park, MD: Maryland Feed Industry Council and Dept. of Animal and Avian Sciences, University of Maryland, USA. Page 91–99.

Noll, S. L., J. Brannon, and C. Parsons. 2007a. Nutritional value of corn distiller dried grains with solubles (DDGS): influence of solubles addition. Poultry Science, 86:68.

Noll, S. L., J. Brannon, and V. Stangeland. 2004. Market tom turkey performance and inclusion level of corn distillers dried grains with solubles. Poultry Science, 83:321.

Noll, S. L., J. Brannon, J. L. Kalbfleisch, and K. D. Roberson. 2005. Metabolizable energy value for corn distillers dried grains with solubles in turkey diets. Poultry Science, 84:12.

Noll, S. L., V. Stangeland, G. Speers, C. M. Parsons, and J. Brannon. 2003b. Market tom turkey response to protein and threonine. Poultry Science, 82:73.

Noll, S. L., V. Stangeland, G. Speers, C. Parsons, and J. Brannon. 2002. Utilisation of Canola Meal and Distillers Grains with Solubles in Market Turkey Diets. Poultry Science, 81:92.

Nyachoti, C. M., J. D. House, B. A. Slominski, and

I. R. Seddon. 2005. Energy and nutrient digestibilities in wheat dried distillers' grains with solubles fed to growing pigs. Journal of Science Food Agriculture, 85:2581-2586.

Olukosi, O. A., A. J. Cowieson, and O. Adeola. 2010. Broiler responses to supplementation of phytase and admixture of carbohydrases and protease in corn-soyabean meal diets with or without corn Distillers' Dried Grain with Solubles. British Poultry Science, 51:434-443.

Ortega, M. M., M. C. Núñez, A. Gil, and A. Sánchez-Pozo. 1994. Dietary nucleotides accelerate intestinal recovery after food deprivation in old rats. J. Nutr. 124(Suppl.):1413-1418.

Oryschak, M., D. Korver, M. Zuidhof, X. Meng, and E. Beltranena. 2010. Comparative feeding value of extruded and nonextruded wheat and corn distillers dried grains with solubles for broilers. Poultry Science, 89:2183-2196.

Ostle, B. 1979. Estadística Aplicada. Limusa. México, D. F.

Parsons, C. M. and D.H. Baker. 1983. Distillers dried grains with solubles as a protein source for the chick. Poultry Science, 62:2445- 2451.

RFA. 2011. Fueling a Nation; Feeding the World. Washington, D.C., USA. 4 p.

Richter, G., H. Hartung, E. Herzog, and F. Otto. 2006. Use of dried wheat-based distillers grain from bioethanol production in poultry. In: IX Tagung Schweine-und Geflugelernahrung, Martin-Luther-Universitat Halle-Wittenberg, Halle, Germany. Page 265-267.

Sánchez-Pozo, A., M. L. Pita, A. Martínez, J. A. Molina, R. Sánchez-Medina, and A. Gil. 1985. Effect of dietary nucleotides upon lipoprotein pattern of newborn infants. Nutri. Res., 6:53-57.

Sanderson, I. R., and Y. He. 1994. Nucleotide uptake and metabolism by intestinal epithelial cells. J. Nutr., 124:131-137.

Scheffler, E. 1982. Bioestadística. Fondo Educativo Interamericano. EE. UU. de N. A. Schingoethe, D. J. 2008. Use of distillers co- products in dietsfed to dairy cattle. Chapter 3, in: B.A. Babcock, D.J. Hayes and J.D. Lawrence (editors). Using Distillers Grains in the U. S. and International Livestock and Poultry Industries. Midwest Agribusiness Trade Research and Information Center. USA.

Scopesi, F., C. M. Verketse, D. Paola, D. Gazzalo, M. A. Pronzato, P. L. Bruschettini, and U. M. Marinari. 1999. Dietary nucleotide supplementation raises erythrocyte 2,3-diphosphoglycerate concentration in neonatal rats. J. Nutr., 129:662-665.

Shim, M. Y., G. M. Pesti, R. I. Bakalli, P. B. Tillman, and R. L. Payne. 2011. Evaluation of corn distillers dried grains with solubles as an alternative ingredient for broilers. Poultry Science, 90:369-376.

Shurson, G. and M. Spiehs. 2002. Feeding recommendations and example diets containing Minnesota-South Dakota produced DDGS for swine. Department of Animal Science, University of Minnesota, St. Paul Minnesota, USA.

Slominski, B. A. 2010. Recent advances in enzymes for poultry diets. The Poultry Federation annual Nutrition Conference 7-9 September 2010. Rogers, Arkansas. USA.www.thepoultryfederation.com/.../2-6%20Wed%20%20Bogdan%20Slominski

ect of dietary nucleosides of growth and maturation of the developing gut in rat. J. Pediatr. Gastroenterology Nutr., 10:497-503.

USDA [United States Department of Agriculture]. 2007. An analysis of the effects of an expansion in biofuel demand on U.S. agriculture. USDA Economic Research Service and The Office of the Chief Economist, Washington, D.C., USA.

Vander Pol, K., G. Erickson, T. Klopfenstein, M. Greenquist, M. and T. Robb. 2006. Effect of dietary inclusion of wet distillers grains on feedlot performance of finishing cattle and energy value relative to corn. Nebraska Beef Cattle Report. pp. 51–53. Lincoln, Nebraska, USA.%20-%20Enzymes%20for%20Poultry.pdf. Spiehs, M. J., M. H. Whitney, and G. C. Shurson.

2002. Nutrient database for distillers dried grains with solubles produced from new ethanol plants in Minnesota and South Dakota. Journal of Animal Science, 80:2639.

Stein, H.H. 2008. Use of distillers co-products in diets fed to swine. In: Using Distillers Grains in the U.S. and International Livestock and Poultry Industries. Chapter 4.

B. A. Babcock, D. J. Hayes and J. D. Lawrence (editors). Midwest Agribusiness Trade Research and Information Center. USA.

Steiner, T., R. Mosenthin, B. Zimmermann, R. Greiner, and S. Roth. 2007. Distribution of phytase activity, total phosphorus and phytate phosphorus in legume seeds, cereals and cereal by-products as influenced by harvest year and cultivar. Journal of Animal Feed Science and Technology, 113:320- 334.

Stryer, L., J. M. Berg, y J. L. Tymoczko. 2013. Bioquímica, con aplicaciones clínicas. 7ma ed. Editorial Reverté. España.

Szczurek, W. 2010. Standardized ileal digestibility of amino acids in some cereals, rapeseed products and corn DDGS for broiler chickens at the age of 14 days. Journal of Animal Feed Science, 19:72-80.

Taheripour, F., T. Hertel, and W. Tyner. 2010. Biofuels and their by-products: global economic and environmental implications. Biomass and Bioenergy, 34: 278–289.

Thacker, P. A. and G. P. Widyaratne. 2007. Nutritional value of diets containing graded

levels of wheat distillers grains with solubles fed to broiler chicks. Journal of Science Food Agriculture, 87:1386-1390.

Tsujinaka, T., M. Kishibuchi, S. Iijima, M. Yano, and M. Monden. 1999. Nucleotides and intestine. J. Parenter. Enteral Nutr., 23:74- 77.

Uauy, R., G. Stringel, R. Thomas, and R. Quan. 1990. Effect of dietary nucleosides of growth and maturation of the developing gut in rat. J. Pediatr. Gastroenterology Nutr., 10:497-503.

USDA [United States Department of Agriculture]. 2007. An analysis of the effects of an expansion in biofuel demand on U.S. agriculture. USDA Economic Research Service and The Office of the Chief Economist, Washington, D.C., USA.

Vander Pol, K., G. Erickson, T. Klopfenstein, M. Greenquist, M. and T. Robb. 2006. Effect of dietary inclusion of wet distillers grains on feedlot performance of finishing cattle and energy value relative to corn. Nebraska Beef Cattle Report. pp. 51–53. Lincoln, Nebraska, USA.

Vilarino, M., J. M. Gauzere, J. P. Metayer, and F. Skiba. 2007. Energy value of wheat-DDGS in adult cockerels and growth performances of broiler chickens. In: 16th European Symposium on Poultry Nutrition, Strasbourg, France. World Poultry Science Association, French Branch, Tours, France. Pages 83-86.

Voet D., and J. G. Voet. 1995. Nucleotide Metabolism. In: Biochemistry. 2nd ed. (N. Rose, ed.) John Wiley and Sons, Inc. New York, NY. Pages 795-797.

Waldroup, P. W., J. A. Owen, B. E. Ramsey, and D. L. Whelchel. 1981. The use of high levels of distillers dried grains plus solubles in broiler diets. Poultry Science, 60: 1479-1484.

Walker, J., J. Jenkins, and T. Klopfenstein. 2011. Protein, fiber, and digestibility of selected alternative crops for beef cattle.

Nebraska Beef Cattle Reports. University of Nebraska, Lincoln, Nebraska, USA.

Wang, Z., S. Cerrate, C. Coto, F. Yan, and P. W. Waldroup. 2007a. Use of constant or increasing levels of distillers dried grains with solubles (DDGS) in broiler diets. International Journal of Poultry Science, 6:501-507.

Wang, Z., S. Cerrate, C. Coto, F. Yan, and P. W. Waldroup. 2007b. Utilisation of distillers dried grains with solubles (DDGS) in broiler diets using a standardized nutrient matrix. International Journal of Poultry Science, 6:470-477.

Whitney, M.H., G. C. Shurson, L. J. Johnston, D. M. Wulf, and B. C. Shanks. 2006. Growth performance and carcass characteristics of grower-finisher pigs fed high-quality corn distillers dried grain with solubles originating from a modern Midwestern ethanol plant. Journal of Animal Science, 84: 3356–3363.

Widyaratne, G. P. and R. T. Zijlstra. 2007. Nutritional value of wheat and corn distiller's dried grain with solubles: Digestibility and digestible contents of energy, amino acids and phosphorus, nutrient excretion and growth performance of grower-finisher pigs. Canadian Journal of Animal Science, 87:103-114.

Yamamoto, S., M. F. Wang, A. A. Adjei, and C. K. Ameho. 1997. Role of nucleotides and nucleosides in the immune system, gut reparation after injury, and brain function. Nutr., 13:372-374.

Yamauchi, K., A. A. Adjei, C. K. Ameho, S. Sato, K. Okamoto, S. Kakinohana, and S. Yamamoto. 1998. Nucleoside-nucleotide mixture increases bone marrow cell number and small intestine RNA content in protein deficient mice after an acute bacterial infection. Nutri., 14:270-275.

Zijlstra, R. T., G. Widyaratne, and E. Beltranena. 2007. Characterization of wheat DDGS and feeding to swine. Proceedings of the 2007 Western Nutrition Conference. Saskatoon. SK, Canada. 211-214. Zijlstra, R.T., C.F.M. De Lange, J. F. Patience. 1999. Nutritional value for wheat for growing pigs: chemical composition and digestible energy content. Canadian Journal Animal Science, 79:187-194.