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ORIGINAL ARTICLE

Influence of Cereals on the Production Performance and Biochemical Profile of Broiler Chickens

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ABSTRACT

Aim: This experiment was conducted to determine the effects of the incorporation of these two cereals on the zootechnical performances, the biochemical profile, the characteristics of the carcass and the consumable offal of chickens.

Methods: 318 broiler chicks (day-old) were divided into 3 lots. In group "barley", maize was partially replaced by crushed barley during the three conventional rearing phases, they are 31%, 32% and 35% respectively. In "triticale group" ; the chickens here consumed a feed in which maize was partially substituted during the three phases, they are 31% at starting, 32% during growth and 35% during finishing, respectively.

Results: The best weight growth was obtained in the group fed the "barley" ration, followed by the "triticale" ration. The lowest live weight was recorded with the "control. On the other hand, the results show that triticale supplementation in the diet does not change the carcass characteristics of the chickens: non-significant variation between the "control" and "triticale" groups (P>0.05).

Conclusion: Barley proved to have a positive influence on production performance such as live weight and carcass yield when incorporated into the ration.

Keywords : Barley, Triticale, Substitution, Performance, Biochimical profil.

INTRODUCTION

Today, it must also be the most environmentally sustainable while preserving food security. Over the past 50 years, agriculture has evolved along with the processing of agricultural products and food manufacturing and with our consumption patterns[1]. For example, in some European countries, ultra-processed products account for at least 36% of calories consumed[2]. The problem is that consumption patterns based on massively processed foods, especially highly or ultra-processed foods, are now widely criticized for their impact on human and animal health[3]. In Algeria, barley and triticale were always excluded from the formulation of locally produced feed rations intended for poultry production because of their high fiber content and the presence of possible anti-nutritional factors. The present experiment analyzes the influence of mainly two modified feed formulas compared to the conventional one on chicken development and production performance.

MATERIALS AND METHODS

Animals and feed rations: 330 one day old broiler chicks were weighed and divided into three lots (110 chicks/lot), one control group and two experimental groups:

The first group, "control", is fed with a standard diet including: corn, soybean meal and wheat bran. This diet is adapted to each rearing phase; "starter feed" distributed from 1st day to 15th day, "growth feed" from 16th day to 45th day and "finishing feed" from 46th day to 56th day (Table 1).

In (group 2), maize was partially replaced by cracked barley during the three classical phases of broiler rearing (Table 2).

In (group 3), the chickens in this group consumed a feed that was partially substituted with corn (Table 3).

The calculations of metabolizable energy and crude protein of the three lots and during each phase of rearing were previously performed. This operation is usually performed by software specialized in animal nutrition. The evolution of the numbers of chicks in the three groups during rearing was followed by daily records of mortality. The quantification of feed consumption, obtained after deduction of the quantities refused, was measured every 24 hours, as well as the daily quantity of water consumed. The evolution of the live weight was carried out by regular weighing at different ages of the animals on a sample of 20 chiks /group. These weighings were carried out at the time of chick placement (1st day), at the end of each 10-day period (10th day; 20th day; 30th day; 40th day and 50th day) and at the end of the rearing cycle 56 days old. Growth control, measured by the average daily gain of the animals, is calculated per rearing phase of start-up, growth and finishing. Finally, the feed conversion ratio was calculated per rearing phase of start-up, growth and finishing.

Statistical analysis: All the results of zootechnical parameters such as live weight (g) and feed conversion ratio as well as biochemical parameters are expressed as (mean ±). Their comparison, both in intra and inter groups, was treated to the one factor analysis of variance (ANOVA) at the significance level (0,05), using the software MINITAB 17 for Windows.

The amount of feed ingested per day was measured to calculate the consumption index. At the end of the experiment, the chickens were taken from each group and individually weighed and sacrificed by bleeding, for the determination of carcass yields. The chickens were hot plucked, eviscerated, heads and feet removed. The Carcasses, the liver, the abdominal fat and the gizzards are also weighed.

Prophylactic program On day 1, we put a rehydrating agent in the drinking water for 4 hours. The antistress was added in the water during the first three days. This treatment was continued during the vaccinations. The chicks were vaccinated against Gumboro and Newcastle diseases. Hepatorenal protector was given to the chicks to support the liver and kidneys during the feeding transition period between the growing and finishing phase, or from 43th day to 47th day.

RESULTS

Effects on zootechnical parameters:

Weight evolution: The best weight growth was obtained in the subjects subjected to the "barley" ration with an average of 3146,2 gr, followed by the one containing "triticale" which recorded a value of 2590 gr. The lowest live weight was recorded with the "control" ration with an average of 2430,50 gr. It should be noted that the values of these last two groups are not significantly different from each other (P>0,05), while the weight growth data of the animals of the "barley" group are different from those of the other two groupes (P<0,05) (Table 4).

Food intake and consumption index: During the rearing period, a progressive increase in feed intake was noted in all lots. All times the feed intake of the "triticale" group where the products were fed a ration containing triticale (31%, 32%, 35%) was below those of the other two groups (control and barley) where the feed intake was equal to 5797,82 gr. On the other hand, the use of barley in the diet induced positive effects on live weight and consequently a slight increase in feed intake (5979,02 gr). The animals of the control lot consumed a quantity very close to that of the "triticale" lot, about 5899,41 gr. It is clear from this table that the feed conversion ratio (FCR) has changed significantly over time. In general, the lowest feed conversion ratio (Feed Conversion) during the trial was observed with the "barley" ration (FC = 1,97). The "control" ration had the highest feed conversion ratio (FC = 2,43). The 'triticale' ration had the highest feed conversion ratio compared to the 'control' ration with a CI = 2,24). The results show that the supplementation of triticale in the diet does not modify the carcass characteristics of the chickens: non-significant variation between the 'control' and 'triticale' groups (P>0,05). We also note a slight increase in carcass weight (2228,5 g) in chickens receiving barley in the diet progressively during the start-up, growth and finishing phases (31%, 32%, 35%). We report that the incorporation of barley in the broiler feed positively and significantly influences the carcass weight of slaughtered chickens (P<0,05). (Table 5 and 6).

Influence of Cereals on the Biochemical Profile:

Starting phase: The highest blood glucose levels were obtained in birds receiving a triticale-containing ration with a value of 2,31 gr/l compared to 2,28 gr/l and 1,98 gr/l for the "barley" and "control" lots respectively. It should be noted that the differences between the blood glucose levels recorded in the three groups were not significant (P>0,05) at the end of the starter phase. The results show that the partial substitution of maize by barley and triticale in the broiler diet during the start-up phase has no significant effect on the uraemia of the animals (p<0,05). The values obtained were 0,032 gr/l and 0,025 gr/l for the "barley" and "triticale" groups respectively, compared to 0,018 gr/l for the "control" group. The highest blood glucose level was obtained in birds fed a triticale-containing ration with a value of 2,31 gr/l compared to 2,28 gr/l and 1,98 gr/l for the 'barley' and 'control' groups respectively. It should be noted that the differences between the blood glucose levels recorded in the three groups were not significant (P>0,05) at the end of the starter phase. The results show that the partial substitution of maize by barley and triticale in the broiler diet during the starter phase does not have a significant effect on the uraemia of the animals (p<0,05). The values obtained are respectively 0,032 gr/l and 0,025 gr/l for the "barley" and "triticale" groups against 0,018 gr/l for the "control" lot. Triglyceride measurement at the end of the starting phase did not reveal any significant difference between the three groups (P>0,05). The control group had an average of 0,56 gr/l, the barley group 0,55 gr/l and the triticale group 0,43 gr/l (Table 7).

The growth: At the end of growth, biochemical analyses indicate that the highest blood glucose level was obtained in the subjects fed the "control" diet with a value of 3,11 gr/l, followed by the animals fed a diet including triticale with an average of 2,076 gr/l. The lowest blood glucose level was reported in the "barley" group with an average of 1,31 gr/l. The analysis of variance concluded that the differences between the blood glucose levels of the three lots were clearly significant (P<0,05). The uremia determination at the end of growth, revealed no significant difference between the three groups (P>0,05). The uremia of the animals of the "control" lot had an average of 0,020 gr/l, against 0,018 gr/l for the animals of the "triticale" lot and 0,015 gr/l for the "barley" lot. The results we obtained concerning cholesterol levels during growth are as follows; (1,77 gr/l) for the "control" lot, (1,42 gr/l) for the "barley" lot versus (0,61 gr/l) for the "triticale" lot. The difference is significant between the "triticale" lot and the other two lots "control" and "barley", while the analysis of variance revealed no difference between the "control" lot and the "barley" lot (P>0,05). The results showed that triglyceride levels were very close at the end of growth. According to the statistical study, no difference was found between the three groupes (P>0,05). We note a decrease in triglyceride levels compared to those recorded during start-up. The chickens of the 'control' group had a slightly higher triglyceride level (0,50 gr/l) than the chickens of the 'barley' lot (0,9 gr/l) and the chickens of the 'triticale' lot (0,36 gr/l) (Table 8).

The finishing: The blood glucose levels recorded at the end of the rearing period were 1,73 gr/l for the chickens in the "control" group, compared with 2,14 gr/l for the chickens in the "barley" group. While the average recorded for the chickens in the "triticale" lot was 2,34 gr/l. According to our results, we found that the partial incorporation of cereals (barley and triticale) in the diet shows that the difference is clearly significant (P < 0,05) between the 'barley' group and the 'control' group and the same between the 'triticale' group and the 'control' group. The variations in blood glucose levels of the experimental groups were not significantly different from each other (P > 0,05). The uremia determination at the final phase did not show any significant difference between the "control" and the "triticale" groups and also between the two experimental lots (barley, triticale) (P>0,05). However, the difference was significant between the control and barley groups. The average uremia of the animals in the "control" group was 0,020 gr/l, compared to 0,010 gr/l for the "barley" group and 0,012 gr/l for the "triticale" group. During the finishing phase, the results of the total protein assay indicate that the partial substitution of maize by barley or triticale in the broiler feed has no significant effect (p<0,05). The values obtained are respectively 24,75 gr/l and 26,40 gr/l for the "barley" and "triticale" groups against 27,80 gr/l for the "control" group. At slaughter, the results show that the overfeeding of cereals in the broiler feed has a significant effect on cholesterol levels compared to the control group (p<0,05). There was also a non-significant difference between the "triticale" and "barley" groups. A slight decrease in cholesterol levels was reported in the "control" group with a value of 0,70 gr/l, unlike the other two groups (triticale and barley) where cholesterol levels increased significantly with 0,91 gr/l for the "barley" lot and 0,98 gr/l for the "triticale" lot. Concerning glycerides at the end of the experiment, statistical analysis revealed no significant variation (P>0,05). However, the lowest value was recorded in the "control" group with an average of 0,45 gr/l, followed by the "triticale" group with a value of 0,50 gr/l. The highest triglyceride level was found in the barley group with an average of 0,77 gr/l (Table 9).

DISCUSSION

The use of cereals in poultry nutrition: The notion of 'diversity' of agriculture's implicitly refers to the recognition of differences in the production and/or valorization processes of agricultural products such as barley and triticale, and therefore to the search for a way to characterize these differences, or even to propose a typology of the forms of implementation in poultry feed and valorization of agricultural and animal production[4], as well as their economic performance, which is generally satisfactory[5]. Dietary fiber was considered an antinutritional factor due to its adverse effects on feed intake and nutrient digestibility. However, with increasing evidence, scientists have found that dietary fiber has enormous impacts on the gastrointestinal tract development, digestive physiology, including nutrient digestion, fermentation, and absorption processes of poultry. It may help maintain the small and large intestine's integrity by strengthening mucosal structure and functions and increasing the population and diversity of commensal bacteria in the gastrointestinal tract. Increasing dietary fiber content benefits digestive physiology by stimulating the gastrointestinal tract development and enzyme production. And the inclusion of fiber at a moderate level in diets also alters poultry growth performance. It improves gut health by modulating beneficial microbiota in the large intestine and enhancing immune functions. However, determining the source, type, form, and level of dietary fiber inclusion is of utmost importance to achieve the above-noted benefits. This paper critically reviews the available information on dietary fibers used in poultry and their effects on nutrient utilization, the gastrointestinal tract development, gut health, and poultry performance[6]. However, the soluble fiber such as β-glucans from barley and oats, arabinoxylans from wheat and rye, pectins from fruits and sugar beet pulp increases intestinal viscosity and decreases the rate of feed passage, which in turn reduce the feed intake and the rate of nutrient absorption and may have an influence on growth performance of poultry. Two defects may restrict the use of barley in poultry feed. The first is the absence of xanthophyll pigments, which can be counterbalanced by the use of raw materials rich in these constituents. The second is due to the possible presence of β-glucans. These are non-starch soluble polyosides consisting of β 1-4 (70 per cent of the bonds) and β 1-3 (30 per cent of the bonds) linked glucose chains.

They are thus distinguished from true cellulose formed of glucose chains linked together by β1-4 bonds only, and from starch whose glucoses are linked in α 1-3. Their content in barley varies from 1.5 to 8.5% (based on dry matter). In general, high contents are associated with harvest conditions where the grain is immature (cold climates in northern regions of Europe or America). There is also an important varietal effect, as malting barley is selected for low β-glucan content. The latter are not hydrolyzed by birds, due to the lack of specific digestive enzymes. They form viscous gels in vitro as well as in vivo; this leads to excretion of water-rich droppings by the birds and moistening of the litter. In addition, growth can be significantly retarded and feed efficiency lowered. The addition of β-glucanases to the feed or drinking water can overcome all these drawbacks. Some studies have shown that that the hulless barley increased the digestive tract tissue weights and lengths, and digesta content, whereas exogenous β-glucanase decreased the same parameters[7]. There are varieties of barley, without glumella. They have characteristics similar to those of wheat: energy value 97% of that of wheat, crude protein (N*6.25) 96% of that of wheat. The energy value is 97% of that of wheat and the crude protein (N*6.25) is 96% of that of wheat. They have an energy value of 97% of that of wheat and a crude protein (N*6.25) 96% of that of wheat. The presence of β-glucans in these varieties is probably responsible for the problems encountered when trying to use such barley as the only cereal[8]. In a study conducted in the United States in 1999, some authors, showed that the inclusion of barley at levels above 30% in broiler diets resulted in reduced growth performance and increased feed conversion[9]. The results remain variable from one experiment to another and depend on several factors such as

The variety of barley incorporated, its chemical composition and nutritional characteristics.

The age of the animals used.

The nutritional characteristics of the diets.

The nature, dose and composition of the added enzyme complexes. The use of feed enzymes in barley-based diets reduces intestinal viscosity, thus improving the feeding value of barley. Enzyme supplementation also reduces the variation in feeding value seen with unsupplemented barley-based diets. Feeding barley cultivars of widely different ß-glucan levels give similar growth performance when supplemented with dietary enzymes. A variety of different feed enzymes are available that have ß-glucanase activity. Using enzymes also improves the litter quality of poultry raised on barley-based diets[10]. The inclusion of 15, 20 or 25% barley without enzyme addition in broiler feeds resulted in performance levels comparable to those of control groups with 10% barley. Diets with 30, 35 or 40% barley in the feed, however, resulted in a significant decrease in weight gain and a significant deterioration in feed efficiency in one trial, but not in another. Similarly, in other trials, there was a non-significant deterioration in performance when the level of barley in the feed reached 50%, particularly for the feed efficiency of the diets and the average weight of the animals at the end of growth. The incorporation of barley in the broiler feed is also accompanied by a proportional and significant decrease in abdominal fat and cecal length. Replacing maize with barley in broiler feeds up to a level of 40% in the presence of commercial enzyme complexes does not appear to have a significant effect on performance. However, increasing the substitution level to 50% or 75% resulted in a significant reduction in weight gain and feed efficiency. The addition of commercial enzyme complexes, at the doses recommended by the suppliers, to diets with high levels of barley results in performance levels identical to those of 'homologous' treatments without enzyme addition. Depending on the type of domestic animal and meal, triticale can be used in significant percentage. The advantage of triticale over other cereals is that it has higher yields, a faster spring growth, and a longer mowing time as a green animal feed, than for example rays or oats. Because of all these advantages, triticale is suitable for planting especially in developing countries[11]. Of the relatively new “man-made” grain species, the most important is a hybrid of wheat and rye called triticale[12]. The triticale is a hybrid of durum wheat {Triticum durum) or common wheat (Triticum aestivum) and rye, artificially obtained in the laboratory. It can withstand the same difficult agronomic conditions as rye and is more productive than it. It should be noted that the protein content in triticale is higher than in conventional cereal crops[13].

On the other hand, from a nutritional point of view, it is clearly superior to rye due to the virtual disappearance of the anti-nutritional factors of rye. The characteristics of field triticale are close to the parental Triticum from which it is derived. The first results obtained on small experimental plots suggested a higher protein content that is not found in conventional cereal crops[14].

According to (Vohra et al, 1991), in their article published in 1991, triticale could be a better substitute for maize in broiler feeds with an incorporation rate varying from 30% to 50%. Results published in 1985 (University of Washington) showed that the growth of broilers was improved with a diet containing 62.5% triticale plus penicillin and hemicellulase[15].

According to (Vilarioo et al, 2005); The performance obtained under practical rearing conditions did not show any difference between wheat and triticale[16]. The average weight at 36 days is similar between all treatments with an average for wheat based feed of (1922 gr) and (1950) for triticale based feed (without enzymes added). In the compound feed of broiler chickens, up to 15% of wheat could be replaced by triticale without affecting performance and digestive processes of broilers[17]. The feed conversion ratios did not show statistically significant differences for any of the cereals used, being 1.86 for wheat and 1.85 for triticale. Other recent works have already demonstrated the possibility of replacing maize by triticale in formulas[18,19].

According to (Vilarino et al, 2005), the incorporation rate of triticale in the diet can reach a percentage of 50%. They concluded that in broilers, the energy of triticale was better valorized than that of wheat[17]. (Antoine et al, 2002) proposed two formulas "pre-laying" and "laying" in which triticale was incorporated at 7% and 10% respectively[20].

According to (Levy and Reichmann, 2011), triticale is rich in starch and lysine (an indispensable amino acid for monogastric animals, which is why it is an economically interesting cereal for animal feed[21]. However, the high viscosity of some varieties can negatively influence the absorption of nutrients and result in sticky droppings (Barier-Guillot et al, 1998), which can lead to a deterioration in the health of the flock, bone deformities and egg fouling[22]. The limits between too high and tolerable viscosity are gradual. Tests were carried out by (26 Djekic et al, 2012) on triticale using four rations in which the incorporation rate varied from 7.5% to 18%[23]. They found that the mortality rate of the groups receiving triticale was slightly higher than that of the control group (P>0.05) while the slaughter weight and feed conversion ratio were higher than those of the control group, which is consistent with our results.

According to (Noirot, et al, 1998) a whole grain diet restores the gizzard to its role as a crushing organ, and it seems that a functional gizzard allows for the mechanical destruction of oocysts[24]. It is noteworthy that, whole wheat inclusions did not significantly influence starch digestibility but phytase inclusions increased distal ileal starch digestibility[25]. The gizzard weight is increased by an average of 1% of the carcass weight by eating whole grain. The action of digestive enzymes and the low pH of the proventriculus, followed by retention of grain particles for a longer period in a better developed gizzard, would allow the feed to arrive partially digested in the duodenum, thus reducing the proliferation of pathogenic bacteria such as Escherichia coli in the intestine. Using optimal combinations of various alternatives coupled with good management and husbandry practices will be the key to maximizing performance and maintaining animal productivity[26].

Cereals and their effects on the biochemical profile: The management of poultry feed is an important welfare promoter and the glycemic index a noninvasive evaluation. Glucose is a major circulating carbohydrate in birds and its level in the blood is often used as a biometric indicator in clinical diagnosis and various studies. Notably, hypoglycemia is often associated with Spiking Mortality Syndrome in broilers; therefore, blood glucose levels need to be correctly evaluated in clinical diagnosis[27,28]. The blood glucose level of chickens and ducks in the fed state averages between 1,90 and 2,20 g/l[29,30]. Reported values in broiler chickens, however, show considerable variation, even in the basal state, ranging from 1.56 to 3.30 g/l without being attributable to the age of the chickens or the method of blood glucose measurement[31]. It should be noted that our results for blood glucose levels in both the protein and grain groups are consistent with those of (Scanes, 2009). Intra- and inter-assay variations are very rarely presented by the authors and variations between laboratories are never mentioned. An international standard for glucose determination in birds would be useful to compensate for the lack of calibration of techniques. Finally, and in contrast to mammals, fasting has little or no effect on blood glucose levels, which is supported by recent studies using modern broiler strains showing that a short fasting period systematically decreases, albeit relatively little, circulating glucose concentration[32, 33]. After hatching, glycolysis is favored over gluconeogenesis. The diet of granivorous birds consists mainly of cereals providing carbohydrates in the form of cellulose and starch. The latter covers about 50 to 60% of the energy requirements of poultry. Starch molecules are mainly hydrolyzed by pancreatic amylases to give rise to dextrins and then maltose, which is rapidly broken down by intestinal enzymes (maltase and isomaltase) into glucose that is absorbed and transferred to the liver via the portal vein. Approximately 30% of ingested carbohydrates are converted to lactate in the intestinal wall. Glucose use varies with age. By measuring the oxidation of glucose by chickens placed in a respiratory chamber, (Buyse et al, 2004) showed that young chicks use most of the ingested glucose for the synthesis of glycogen and non-essential amino acids. In contrast, at the end of growth (5-6 weeks of age), chickens oxidize most of the ingested glucose for energy purposes. This period is characterized by an exponential increase in fat deposition[34]. Hypoglycaemia and electrolyte imbalances such as hypokalaemia are the two most common causes. They are often themselves the result of another condition (enteritis, feed sorting or refusal, intestinal coccidiosis, litter ingestion). During accidental fasting where some animals fail to mobilize their energy reserves. Hypoglycaemia occurs, diagnosed for a blood glucose level of less than 0.15 g/l in chickens[35]. The metabolic pathways identified in mammals are, on the whole, operational in birds with quantitative but also qualitative variations and differences in the relative contribution of certain pathways[36].

Blood glucose levels in chickens and birds in general are dependent on insulin in the fed state and glucagon in the fasted state. The critical role of insulin has been demonstrated after near-total pancreatectomy or after immunoneutralisation. These procedures result in marked hyperglycaemia. The role of glucagon is highlighted by the fact that fasted and pancreatectomised chickens develop hypoglycaemia. The control of insulin secretion has been the subject of several reviews[37]. While in mammals glucose is the primary physiological regulator of insulin secretion, the insulinotropic effect of glucose is less obvious in birds. According to (Kurtoglu et al, 2004) niacin "Vitamin B3" supplementation led to a decrease in egg cholesterol content as well as in serum cholesterol and triglyceride concentrations[38]. It should be remembered that protein crops are relatively low in niacin compared to cereals, which justifies that the cholesterol and triglyceride levels recorded in chickens fed "cereals" are relatively higher compared to the results obtained in subjects consuming "protein crops". Cholesterol metabolism is closely linked to lipoprotein metabolism. Cholesterol is a lipid of the sterol family. It is one of the lipid components of cell membranes. It also acts as a precursor of bile acids, steroid hormones and calcitriol. The majority of the body's cholesterol is obtained by endogenous synthesis and biliary recycling, with the remainder supplied by the average diet, although endogenous synthesis is theoretically sufficient to cover the body's needs. In birds, lipogenesis, including cholesterol synthesis, is also thought to occur mainly in the liver. As cholesterol is synthesized by the hepatocytes, it should be noted that low cholesterol levels significantly different from the norm have been reported in some chickens. This could be explained by the reduction in the amount of food following systems, and therefore the amount of sugar reaching the liver[39]. Absorbed cholesterol comes from two main sources: the diet and biliary cholesterol from the enterohepatic circulation. Esterified cholesterol from the diet is hydrolyzed to free cholesterol, which mixes with biliary cholesterol and is then taken up by the enterocytes along with other lipids and esterified in the intestinal mucosa. This cholesterol mixes with the cholesterol synthesized in the intestine and the whole will be incorporated into chylomicrons which will be captured by the liver as we have seen previously. Similarly, we have seen that cholesterol is also transported from the liver to extra-hepatic tissues via LDL and from extra-hepatic organs to the liver via HDL. Half of the cholesterol is excreted in the faeces after conversion to bile acids, while the rest is excreted as neutral steroids. Most of the cholesterol secreted into the bile is reabsorbed; this is called the enterohepatic circulation. In the short term, cholesterol synthesis is regulated in the liver, where the rate of cholesterol synthesis depends on the activity of 3-hydroxy-3-methylglutaryl-CoA reductase (HMG-CoA reductase). Phosphorylation, catalyzed by HMG-Co reductase kinase, inactivates the enzyme. Dephosphorylation catalyzed by a phosphatase activates the enzyme. In the long term, the regulation of intracellular cholesterol concentration is achieved by the cholesterol distributed in the chylomicron remnants, LDL and HDL, and it provides information on the level of cholesterol in the body. Its effects are threefold:

It inhibits the activity of HMG-CoA reductase, the starting point for de novo cholesterol synthesis.

If cholesterol is not used and accumulates, it activates an acyltransferase (Acyl-CoA: Cholesterol acyltransferase; ACAT). Cholesterol esters, thus formed, are stored in the cells. - Excess cholesterol also inhibits the transcription of LDL receptor genes, thus reducing their number and the uptake of LDL and thus the supply of cholesterol to the cells. The highest production of uric acid is with the ingestion of muscle meat, which not only contains nucleoproteids but is rich in preformed purine. May also be due to excess protein in the diet (wheat flour - corn flour). High protein rations always increase blood uric acid. Also kidney inflammation is often a necessary occasional cause. Anatomical or physiological alterations of certain organs (especially the intestine, pancreas and liver), uricopoietic and uricolysis, can lead to increased uric acid production, when the uricopoietic organs are over-functioning or the solubility of urates in the blood is reduced. Sedentary life, lack of exercise, and the confined state in which some birds live favour, to a large extent, the deposition of sodium urate. The difference in urea can be linked to the rearing conditions and the diet[40].

CONCLUSION

The cereals studied can be used as a substitute energy source for maize, although their energy content is never very high. Many points remain unclear about the nutritional value of cereals grown in Algeria. However, it is clear that high inclusion levels can be envisaged when various situations similar to those in these trials are encountered. The use of cereals in their raw state and at inclusion levels of up to 30% for cereals presented in mealy form gives relatively acceptable performance without disturbance of biochemical parameters.

Table 1: Composition of the starter feed for the "control" and "experimental" lots

Raw materials (100 kg)	Ration 1 (control)	Ration 2 (Barley)	Ration 3 (triticale)
Maize	62%	31%	31%
Barley	/	31%	/
Triticale	/	/	31%
Soybean meal	30%	30%	30%
wheat bran	5%	5%	5%
Phosphate bi-calcique	2%	2%	2%
Vitamin Mineral Complex	1%	1%	1%
Metabolisable energy (Kcal/kg)	2912	2812,7	3218,69
Crude protein (%)	20,45	20,94	22,64

Table 2: Composition of the growth feed of the "control" and "experimental" lots

Raw materials (100 kg)	Ration 1 (control)	Ration 2 (Barley)	Ration 3 (triticale)
Maize	64%	32%	32%
Barley	/	32%	/
Triticale	/	/	32%
Soybean meal	28%	28%	28%
wheat bran	5%	5%	5%
Phosphate bi-calcique	2%	2%	2%
Vitamin Mineral Complex	1%	1%	1%
Metabolisable energy (Kcal/kg)	2933	2830,4	3229,44
Crude protein (%)	19,75	20,26	21,82

Table 3: Composition of the finishing feed of the "control" and "experimental" lots

Raw materials (100 kg)	Ration 1 (control)	Ration 2 (Barley)	Ration 3 (triticale)
Maize	70%	35%	35%
Barley	/	35%	/
Triticale	/	/	35%
Soybean meal	22%	22%	22%
wheat bran	5%	5%	5%
Phosphate bi-calcique	2%	2%	2%
Vitamin Mineral Complex	1%	1%	1%
Metabolisable energy (Kcal/kg)	2995	2883,5	3261,69
Crude protein (%)	17,66	18,22	19,33

Table 4: Influence of barley and triticale incorporation on live weight

	Lot « Control »	Lot « Barley »	Lot « triticale »	ANOVA (P)		
				*	**	***
Live weight (gr)	2430,50 ±593,8	3146,2 ± 241,1	2590,0 ±398,8	S	NS	S

Table 5: Effects of cereals on food intake, weight growth and feed conversion

	Food intake (gr)		
	Lot « Control »	Lot « Barley »	Lot « Triticale »
Starting (1st day - 15th day)	369,7	332,12	380,93
Growth (15th day - 45th day)	3593,7	3207,48	3390,34
Finishing (45th day - 56th day)	1936,01	2222,18	2026,55
Cumulative (1st day - 56th day)	5899,41	5979,02	5797,82
	Weight growth (gr)		
	Lot « Control »	Lot « Barley »	Lot « Triticale »
15th day	230,80	247,14	249,28
45th day	1838,70	1821,15	1827,08
56th day	2430,50	3146,2	2590,0
	Feed conversion		
	Lot « Control »	Lot « Barley »	Lot « Triticale »
Starting (1st day - 15th day)	1,60	1,34	1,53
Growth (15th day - 45th day)	2,24	2,04	2,15
Finishing (45th day - 56th day)	3,27	1,82	2,66
Cumulative (1st day - 56th day)	2,43	1,97	2,24

Table 6: Influence of barley and triticale incorporation on carcass yield

	Lot « Control »	Lot « Barley »	Lot « Triticale »	ANOVA (P)		
				*	**	***
Carcass weight (gr)	1703,56±454,72	2228,2 ±181,8	1849,5± 287,3	S	NS	S
Rendement carcasse (%)	69,66 ±2,2	73,23 ±3,361	71,46 ± 3,517	NS	NS	NS

Table 7: Effects of cereals on the biochemical profile during the starting phase

	Lot « Control »	Lot « Barley »	Lot « Triticale »	ANOVA		
				*	**	***
Blood sugar (gr/l)	1,98 ± 0,81	2,28 ± 0,20	2,31 ± 0,46	NS	NS	NS
Uremia (gr/l)	0,018 ±0,004	0,032 ±0,02	0,025 ±0,01	NS	NS	NS
Total protein (gr/l)	17,80 ±5,59	26,20 ±4,82	28,00 ±8,04	S	NS	NS
Cholesterolemia (gr/l)	0,67 ±0,31	1,198 ±0,36	1,00 ±0,35	S	NS	NS
Triglycerides (gr/l)	0,56 ±0,48	0,54 ±0,16	0,43 ±0,11	NS	NS	NS

Table 8: Effects of cereals on the biochemical profile during growth

	Lot « Control »	Lot « Barley »	Lot « Triticale »	ANOVA		
				*	**	***
Blood sugar (gr/l)	3,11 ±0,71	2,08 ±0,31	1,31 ±0,28	S	S	S
Uremia (gr/l)	0,02 ±0,01	0,015 ±0,01	0,018 ±0,004	NS	NS	NS
Cholesterolemia (gr/l)	1,77 ±0,75	1,42 ±0,25	0,61 ±0,20	NS	S	S
Triglycerides (gr/l)	0,50 ±0,17	0,39 ±0,10	0,36 ±0,10	NS	NS	NS

Table 9: Effects of cereals on the biochemical profile during finishing

	Lot « Control »	Lot « Barley »	Lot « Triticale »	ANOVA		
				*	**	***
Blood sugar (gr/l)	1,73 ±0,21	2,14 ±0,06	2,34 ±0,34	S	S	NS
Uremia (gr/l)	0,02 ±0,01	0,010	0,01 ±0,004	S	NS	NS
Total protein (gr/l)	27,80 ±2,17	24,75 ±4,03	26,40 ±4,67	NS	NS	NS
Cholesterolemia (gr/l)	0,70 ±0,09	0,91 ±0,10	0,98 ±0,19	S	S	NS
Triglycerides (gr/l)	0,46 ±0,11	0,77 ±0,46	0,50 ±0,17	NS	NS	NS

*: Comparison between the "control" lot and the "barley" lot
** : Comparison between the "control" lot and the "triticale" lot
*** : Comparison between the " barley" lot and the " triticale" lot
S : significant difference (P < 0,05), NS : not significant difference (P > 0,05)

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