

# Histological study of proventriculus and spleen of broiler due to adding of guar (*Cyamopsis tetragonoloba*) meal

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**Abstract**— This investigation at hand was conducted to evaluate histological changes of proventriculus and spleen of broiler that fed a vegetable diet contains 10% guar (*Cyamopsis tetragonoloba*) meal powder. 60 birds (Ross 308 strain) used were assigned into two groups with thirty chicks, fed on vegetable diet contain protein, the first group fed on diet contain 0% of guar meal powder as a control group (G1), and the second group (G2) fed diet contain 10% of guar meal till the end of the experiment, so the current study revealed that the guar meal was effective on digestion process in proventriculus led to histological effective on the proventriculus which a statistically significant increase  $P \leq 0.05$  was observed in the diameter of proventricular glands, along with a similar significant increase  $P \leq 0.05$  in diameter of the lumen of the proventricular glands, while there was no significant difference in the diameter of white pulp of the spleen.

**Keywords** — proventriculus, spleen, broiler, guar (*Cyamopsis tetragonoloba*).

## INTRODUCTION

Human demographic expansion, rapid urbanization, and improvements in an incoming levels have collectively contributed to the growing demand for animal-derived food products in low and middle income countries (1, 2). In response to the rising demand had led to remarkable growth in global manufacture of animal-derived foods especially from broiler chickens. In this regard, (3) noted the contribution of broiler meat is around 33% of the total global meat production. (4, 5, 6). However, the raising consumer demands for these products has contributed to an increase in the prices of chicken derived commodities in a country (7). It had been a common experience that with the growing demand for animal-based protein has led to an increased need for high quality feed ingredients especially those rich in protein and energy content (8, 9).

An inexpensive and locally available vegetable feed ingredients across the world can be excellent alternative feed

resources for poultry diets instead of using animal feed ingredients (10, 11).

Guar meal a by-product obtained from the industrial processing of guar seeds for gum extraction, represents a cost-effective and readily accessible feed resource. Due to its favorable amino acid composition and relatively high crude protein content ranging from 33% to 45%, it holds potential as a nutritional supplement to mitigate this issue (12, 13). Guar Meal (GM) is a cost effective high protein by-product derived from the processing of guar gum. Its protein content varies between 33% and 60% depending on the specific fraction used (14, 15).

## LITERATURES REVIEW

Guar (*Cyamopsis tetragonoloba*) is a bushy, erect yearly herbaceous leguminous herb that can reach up to 3 meters in height. It bears trifoliate leaves that may extend up to 10 cm in length and produces white or pinkish flowers. The plant develops straight, pale green pods each containing 5 to 12 hard seeds (16).

The term 'guar' is believed to have originated from the traditional use of the plant and its by-products as cattle feed. The name is derived from the combination of two words; Gow meaning cow and Ahaar meaning feed, reflecting its significance in livestock nutrition (12).

Guar meal, the primary by-product of guar gum extraction consists predominantly of hulls combined with a smaller proportion of germ material, typically in a ratio of approximately 75% hull to 25% germ (17). This protein dense material comprising approximately 42% cured protein, is commonly incorporated as a feed ingredient. However, it often necessitates processing to enhance its palatability and to eliminate or reduce the presence of anti-nutritional factors (12).

The structure of the avian stomach exhibits morphological variations that are closely related to their feeding strategies (18, 19). In such birds, the stomach is anatomically divided into two distinct regions; the glandular part which is referred to as the proventriculus also described as the glandular stomach, and the ventriculus or gizzard, known as the muscular stomach. These two compartments are demarcated by a transitional intermediate zone (20, 21, 22).

The spleen constitutes the largest mass of lymphoid tissue in the human body and is uniquely positioned within the bloodstream. Due to its rich content of phagocytic cells, it plays a crucial role in the removal of senescent erythrocytes. Similar to other lymphoid organs, the spleen serves as a site for the activation and proliferation of lymphocytes. Structurally, the spleen is composed of a parenchyma enclosed by a fibrous capsule that extends inward to form trabeculae of varying lengths. The parenchyma itself is organized into two distinct regions: white pulp and red pulp (23, 24).

A study carried out in the department of animal nutrition, university of agriculture, Faisalabad in Pakistan, demonstrated that the inclusion of guar meal in broiler diets, up to a level of 12%, had no adverse effects and significantly enhanced growth performance and weight gain in birds (12). Enhancing poultry performance through dietary strategies has long been a primary objective for poultry nutritionists. One approach to achieving this goal involves adjusting and refining the nutrient recommendations established by the National Research Council (NRC) (25, 26). Guar meal has been reported to increase intestinal viscosity which consequently impairs nutrient digestibility and reduces growth performance (27), and it is an interesting feedstuff due to its relatively high protein content, 40-45 % dry matter for the regular meal. Its lysine (1.72 % dry matter) and sulphur amino acids (methionine + cysteine 0.96 % dry matter) the composition is similar to that found in groundnut meal; however, they are considerably lower than those present in soybean meal (28).

The incorporation of guar by-products into poultry diets represents a potentially cost-effective strategy for reducing feed expenses without compromising production performance as long as the inclusion levels remain below 10% and preferably under 5%. Furthermore, processing treatments of guar products can lead to a slight enhancement in their nutritional value (29, 30).

## MATERIALS AND METHODS

The study was carried out in the poultry farm in the holy city of Karbala from 26/1/2025 to 7/3/2025. Sixty birds of broiler chick (Ross 308 strain). Chickens were housed in an environmentally controlled pens with standard feeding and watering system. They were assigned to two groups with thirty chicks, fed on vegetable diet contain protein, the first group fed on diet contain 0% of guar meal powder as a control group (G1), and the second group (G2) fed diet contain 10% of guar meal till the end of the experiment, the diet formed by pelleting operation. On day 42, the chicken were humanely euthanized via cervical dislocation, and the entire digestive tract was subsequently dissected with care. A small part of proventriculus after removing the contents, and a small part of spleen were removed for histological measurements and histological examination according to (31, 32).

### The measurements

- 1) Measuring the diameter of glands of proventriculus of birds fed on diet (0% guar meal) and (10% guar meal).

- 2) Measuring the diameter of duct (lumen) of glands of proventriculus of birds fed on diet (0% guar meal) and (10% guar meal).
- 3) Measuring the diameter of white pulp of birds fed on diet (0% guar meal) and (10% guar meal).

Dimensions were done by using oculometer by taking the height and width and then take the average of them, repeated for 20 specimens, selected 10 histological sections for each sample and repeated that for 10 animals to reach total number of 100 and then counted the arithmetic means).

### Statistical Analysis

All data were analyzed statistically by using T-test and one way analysis of variance (ANOVA) and the means were compared for statistical significance using the Least Significant Difference (L.S.D) test, conducted through SPSS software (33).

## RESULTS

In the current study, the normal histological architecture of the proventriculus was demonstrated the proventricular wall consists of four histologically distinct layers: the mucosal layer (tunica mucosa gastris), the submucosa layer (tunica submucosa gastris) the muscularis (tunica muscularis gastris), and the outermost serosal layer (tunica serosa gastris). The mucous membrane exhibited prominent folds projecting into the luminal surface (fig. 1). The mucosal folds exhibited variable heights and were covered by a simple columnar epithelium. These folds From their base there are a simple, short tubular glands extended into the lamina propria. The epithelial cells lining these glands resembled those covering the surface of the folds.. The lamina propria of submucosal layer showed the majority of the of the proventricular wall was composed of a numerous proventricular glands that open into the mucosal surface. The secretory units were elongated oval and lined by cuboidal cells giving them a dentate appearance. However, each glandular group drained by their lumen into the main proventricular lumen (fig. 2 and 3).

On the other hand the present study showed that the parenchyma or the splenic pulp of spleen surrounded by thin capsule. The spleen was composed of a network of reticular tissue that contains reticular cells, the splenic pulp was composed of two distinct regions: white pulp and red pulp. The white pulp included periarterial lymphatic sheaths and lymphoid follicles, which were rich in lymphocytes and other immune cells. In contrast, the red pulp was formed by splenic cords interspersed with blood-filled sinusoids (fig. 5 and 6).

In this study we observed when adding of 10% guar meal powder to the vegetable diet of the broiler showed there was a significant increase at  $p \leq 0.05$  in the diameter of proventriculus glands which was  $284.75 \pm 18.09 \mu\text{m}$  due to enlargement of these glands which thought to increase activity of these glands because of increase of protein in the diet with 10% guar meal powder in compare with 0% guar meal powder which was  $176.25 \pm 5.87 \mu\text{m}$  (fig. 4) , table (1), and also there was a significant increase at  $p \leq 0.05$  in the diameter of the lumen of proventricular glands which was  $180 \pm 10.83 \mu\text{m}$  when adding 10% guar meal powder to the vegetable diet of the broiler due



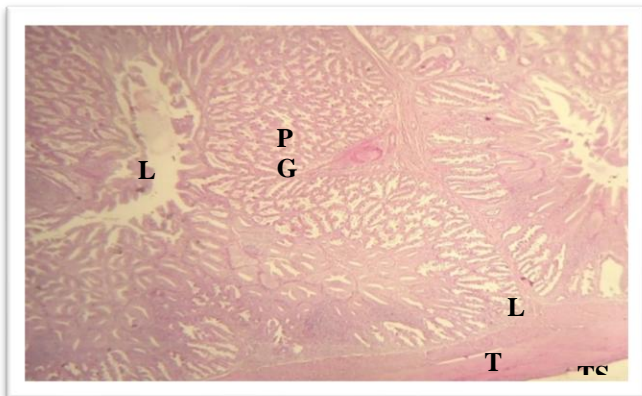
to increase in the secretion of proventriculus glands in compare with 0% guar meal powder which was  $49.5 \pm 2.26 \mu\text{m}$  (fig. 4), table (1).

Conversely, our findings revealed no statistically significant differences at  $p \leq 0.05$  in the diameter of the white pulp of spleen which was  $16 \pm 0.98 \mu\text{m}$  when the broiler birds fed with vegetable diet contain 10% of guar meal in compare with 0% guar meal diet which was  $16.2 \pm 0.51 \mu\text{m}$ , (fig. 7 and 8), table (1).

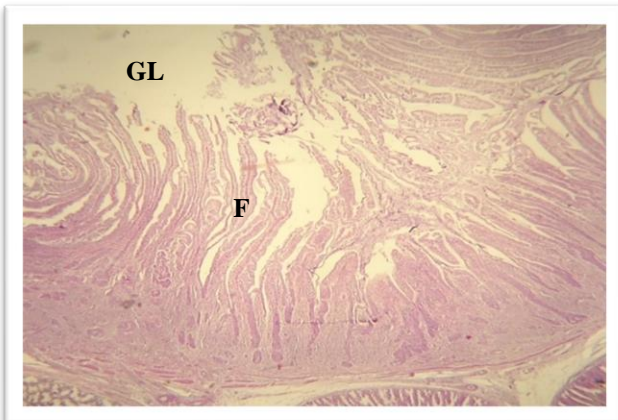
**Table 1. The diameter of proventriculus glands with their lumens, and the diameter of white pulp of spleen.**

Specimen Concentration	Diameter of white pulp ( $\mu\text{m}$ )	Diameter of proventricular glands ( $\mu\text{m}$ )	Diameter of lumen of proventricular glands ( $\mu\text{m}$ )
0% guar meal diet	$16.2 \pm 0.98$ A	$176.25 \pm 0.98$ B	$49.5 \pm 2.26$ B
10% guar meal diet	$16 \pm 0.51$ A	$284 \pm 18.09$ A	$180 \pm 10.83$ A

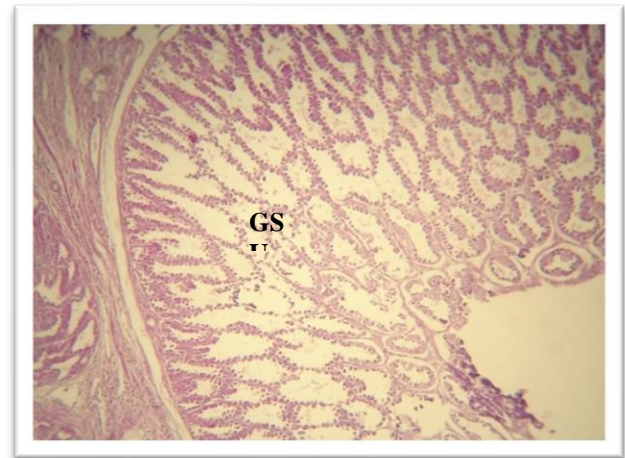
Means with the same letters are not significantly different in the same column.



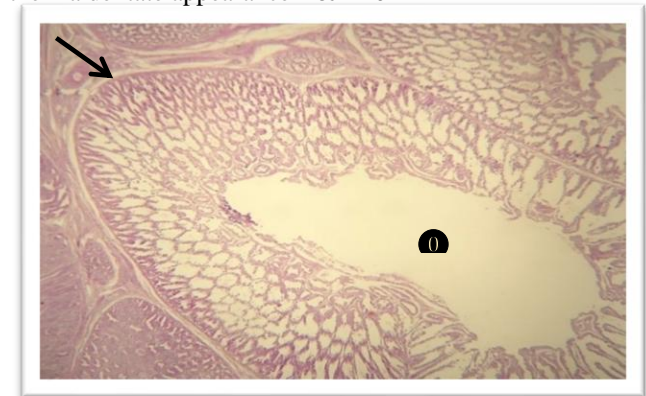
**Figure 1.** histological cross section of normal structure of proventriculus which appear, tunica serosa (TS), tunica muscularis (TM), lamina propria (LP), proventricular glands (PG) and lumen of the gland (L), H&E 40X.



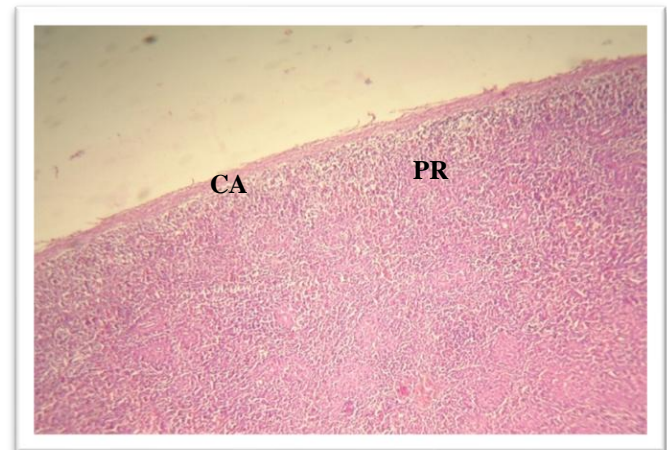
**Figure 2.** histological cross section of normal structure of proventriculus which appear, main glandular lumen (GL), and folds with a simple columnar epithelium (F), H&E 10X



**Figure 3.** histological cross section of normal structure of proventriculus showed glandular secretory units (GSU) with a simple cuboidal epithelium lining giving them a dentate appearance H&E 40X

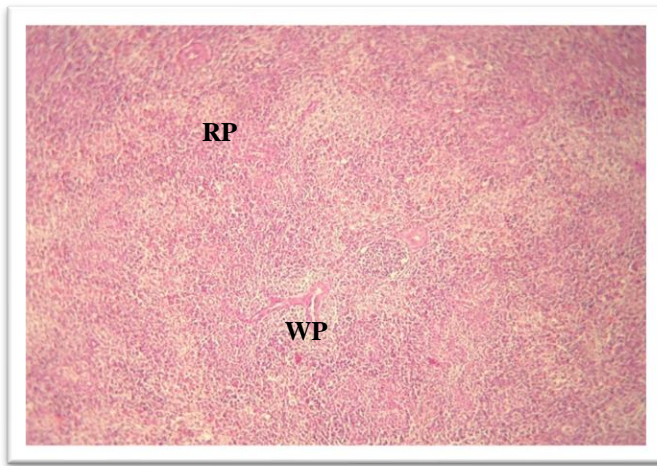


**Figure 4.** histologically proventriculus with 10% guar meal diet which appear, enlargement of proventricular glands. ( —————> ) with their lumen ( O ), H&E 10X

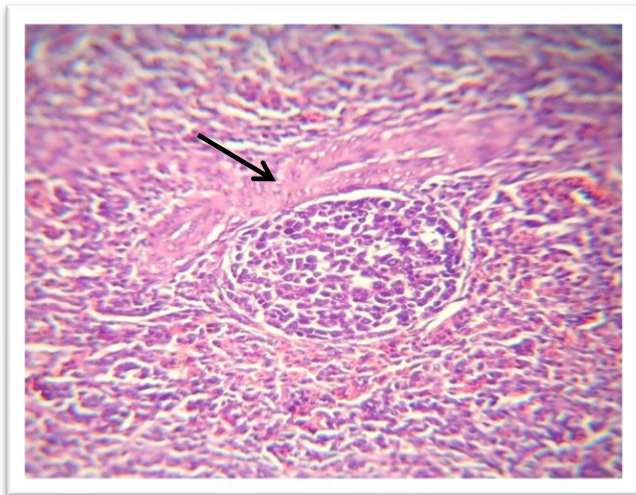


**Figure 5.** histological cross section of normal structure of spleen showed thin capsule (CA) and splenic pulp or parenchyma (PR) H&E 10X

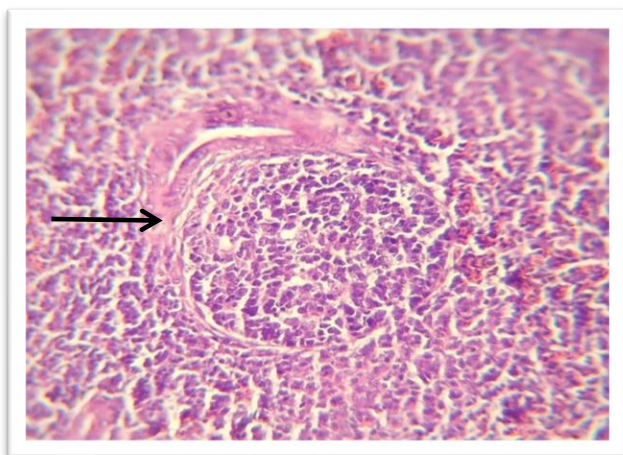




**Figure 6.** histologically normal structure of spleen red pulp (RP) and white pulp (WP) H&E 10X



**Figure 7.** histological cross section of normal structure of white pulp of spleen . ( —————> ) with 0% guar meal diet, H&E 40X



**Figure 8:** histologically normal spleen structure of white pulp (—————>) with 10% guar meal diet, H&E 40X

## CONCLUSIONS

The present study showed that the normal histological picture of proventriculus had four layers: tunica mucosa gastris, tunica submucosa gastris, tunica muscularis gastris and tunica serosa gastris, the mucous membrane manifested into the luminal surface a prominent folds projections, these folds varied in height and lined by a simple columnar epithelium also these folds had a short simple tubular glands with a secretory units giving them a dentate appearance, so we agreed with (34, 35) who observed that the mucosal layer of the proventriculus was distinguished by the presence of longitudinal mucosal folds lined with simple columnar epithelium. Tubular glands were embedded within the lamina propria, whereas the submucosa comprised numerous well-developed proventricular glands. Conversely, the findings of the present study revealed that the splenic parenchyma enclosed by a thin fibrous capsule and had white and red pulp, these the same observations of (23, 36) who described the spleen as a lymphoid organ richly supplied with blood enclosed by a connective tissue capsule extends inward to give rise to trabeculae extend into the parenchyma and the parenchyma divided into white pulp as immunological component and red pulp which its function primarily in filtering the blood.

This study when adding of 10% guar meal powder to the diet of the broiler revealed there was a significant increase in the diameter of proventriculus glands and also there was a significant increase in the diameter of the lumen of proventricular glands when also adding 10% guar meal powder to the diet of the broiler, these agreed with (14, 37) who observed that the guar meal exhibited a rich amino acid and contained crude protein levels ranging between 33% and 45% and that increased the activity of the glandular stomach and makes it a useful protein supplement for broilers and layers.

In contrast, our findings observed no statistically significant difference in the diameter of the white pulp of spleen when the broiler birds fed with vegetable diet contain 10% of guar meal in compare with 0% guar meal diet these, agreed with (38, 39) who observed that the inexpensive and locally available vegetable feed ingredients with guar meal had excellent alternative feed resources for poultry diets instead of using animal feed ingredients and also had higher biological value with no immunological effect.

## CONCLUSION

The results of the present study concluded that the guar meal was effective on digestion process in proventriculus led to histological change in the proventriculus of birds enhancing digestion activity of the broiler.

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