

## Carcass characteristics and hepato-histopathological examination of Hyla rabbit fed graded levels of watermelon rind-wheat offal mix

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### Abstract

*This study was conducted to evaluate the carcass characteristics and hepato-histopathological examination of Hyla rabbits fed graded levels of watermelon rind-wheat offal mix. In a sixteen-week trial, 45 Hyla rabbits of 5-6 months of age with an average weight of  $1.84 \pm 0.01$  kg were allotted to five dietary treatments containing 0, 10, 20, 30 and 40% of watermelon rind-wheat offal mix levels in a completely randomized design with nine rabbits per treatment. Four rabbits were randomly selected from each treatment group and slaughtered for carcass evaluation and histopathological changes in the kidney and liver. Watermelon rind-wheat offal mix (WRWO) had no significant ( $P > 0.05$ ) effect on the carcass characteristics except in the live weight and bled weight of Hyla rabbits. Rabbits fed  $T_4$  had the highest live weight value (2.36 kg) which was significantly higher ( $p < 0.05$ ) than others. Rabbits in  $T_4$  had a significantly higher ( $P < 0.05$ ) value (2.02 kg) for bled weight than that of rabbits in  $T_2$  (1.53 kg). It was concluded that watermelon rind-wheat offal mix can be included in the diets of Hyla rabbits up to 40% without adverse effect on their carcass characteristics and hepato-histopathological examination.*

**Keywords:** Carcass; hepato-histopathological; Hyla rabbits; watermelon; rind; wheat offal

**Running title:** Carcass characteristics and hepato-histopathological examination of rabbit fed watermelon rind-wheat offal mix

## Caractéristiques des carcasses et examen hépato-histopathologique de lapins Hyla nourris avec un mélange écorce de pastèque-abats de blé à teneurs graduées



### Résumé

*Cette étude a été menée afin d'évaluer les caractéristiques des carcasses et l'examen hépato-histopathologique de lapins Hyla nourris avec un mélange écorce de pastèque-abats de blé à teneurs graduées. Lors d'un essai de seize semaines, 45 lapins Hyla âgés de 5 à 6 mois, pesant en moyenne  $1,84 \pm 0,01$  kg, ont reçu cinq traitements alimentaires contenant 0, 10, 20, 30 et 40 % de mélange écorce de pastèque-abats de blé, selon un protocole entièrement randomisé, avec neuf lapins par traitement. Quatre lapins ont été sélectionnés aléatoirement dans chaque groupe de traitement et abattus pour une évaluation de la carcasse et des modifications histopathologiques des reins et du foie. Le mélange écorce de pastèque-abats de blé (WRWO) n'a eu aucun effet significatif ( $p > 0,05$ ) sur les caractéristiques de la carcasse, sauf sur le poids vif et le poids saigné des lapins Hyla. Les lapins nourris au  $T_4$  présentaient le poids vif le plus élevé (2,36 kg), significativement plus élevé ( $p < 0,05$ ) que les autres. Les lapins du  $T_4$  présentaient un poids saigné significativement plus élevé ( $p < 0,05$ ) (2,02 kg) que celui des lapins du  $T_2$  (1,53 kg). Il a été conclu que le mélange écorce de pastèque-abats*

*de blé pouvait être inclus dans l'alimentation des lapins Hyla jusqu'à 40 % sans effet néfaste sur les caractéristiques de la carcasse et l'examen hépato-histopathologique.*

**Mots-clés :** Carcasse, hépato-histopathologique, lapins Hyla, pastèque, écorce, abats de blé

**Titre courant :** Caractéristiques de la carcasse et examen hépato-histopathologique de lapins nourris au mélange écorce de pastèque-abats de blé

### Introduction

There is inadequate protein supply in the diet of most people living in developing countries like Nigeria (Ahamefule *et al.*, 2005; Igwebuiké *et al.*, 2005). This protein intake inadequacy is related to high cost of conventional feed ingredients, inadequate provision of high quantity and quality forage during dry seasons, high cost of animals of protein sources and high demand with low supply. Some authors (Attia *et al.*, 2011; Oseni, 2012; Oloruntola *et al.*, 2015) reported that in earlier times a case for rabbit production as a realistic approach to counter the animal protein deficit in the diets of Nigerians. These authors reported that the use of prolific animals and alternative non-conventional feed ingredients for feeding livestock are strategies for advancement in livestock production. Rabbits are prolific, with short gestation length, early sexual maturity and ability to rebreed several times within a year, high reproduction potential and ability to utilize non-competitive feeds (Uchewa *et al.*, 2014; Oloruntola *et al.*, 2015). The meat from rabbit surpasses meat from other farm animals in protein content (Kumar *et al.*, 2023). It also contains low cholesterol, fewer calories and a lower percentage of fat compared to beef, pork, chicken or lamb (Kumar *et al.*, 2023). Rabbit meat production has been on the increase in Nigeria in the past years, this is because rabbit is the most productive meat-producer among all domesticated animals (Odeyinka *et al.*, 2007). Rabbit meat is prescribed safe and healthy for consumers (Wang *et al.*, 2020). Hyla rabbit, one of famous breeds of rabbit in Nigeria is reported to be a productive breed that is used in

many cross-breeding programmes for genetic improvement.

Feed supply has remained a major constraint in livestock production because of the ever-increasing cost of conventional feedstuff occasioned by the competition between humans and livestock for both cereal grains and legume seeds (Ahamefule *et al.*, 2004). Amadi *et al.* (2018) and Ominiski *et al.* (2021) opined that one of the possible ways of overcoming food security challenges *vis-a-vis* growing population is the exploitation of the underutilized agro-industrial by products. Watermelon fruit (*Citrullus lanatus*) has deep green, smooth thick exterior rinds with grey or light green vertical stripes. Dubey *et al.* (2021) concluded that the most underutilized portion of watermelon, the rind possess good efficiency to be utilized not only in food industry but also in other sectors. The knowledge of the nutritive and anti-nutritional effects of watermelon waste such as rind on the performance, carcass characteristics, hematological and histopathological changes in livestock will provide the optimum level that can be included in the diet without deleterious effects. Johnson *et al.*, 2012 carried out the evaluation of anti-nutrient contents (mg/100g) in dried watermelon rind and reported 2.93, 1.42, 0.00, 1.15, 0.43, 0.45, 0.07 and 2.63 for saponin, alkaloid, hydrocyanide, tannin, phytate, phenol, oxalate and flavonoids, respectively. The authors concluded that watermelon rind can contribute immensely to daily allowance and maintenance of nutrients required and good health for animals. Water-melon is a high-moisture fruit associated with difficulty in conversion of high-moisture by-products

arising from high cost of drying equipment and lack of simple and appropriate alternatives (Makinde and Sonaiya, 2010). Makinde and Sonaiya (2010) developed a quick method to convert into animal feeds such wet by-products using vegetable carriers (wheat offal, dried rumen contents, maize offal and brewers' dried grains) as absorbents. Olosunde *et al.* (2023) reported that watermelon waste can be processed into unconventional feedstuff by mixing it with wheat offal as absorbent. There is need for supplementation of both cereal grains and legume seeds with under-utilized unconventional feedstuff such as watermelon waste (Awoyomi *et al.*, 2022) as a means of reducing production cost as well as competition between man and livestock. Thus, this study conducted to evaluate the carcass characteristics and hepato-histopathological examination of Hyla rabbits fed graded levels of watermelon rind-wheat offal mix.

**Materials and methods**

The experiment was conducted at Bora, Federal College of Animal Health and Production Technology, Ibadan. In a 16-week trial, 45 Hyla rabbits of 5-6 months of age with an average weight of 1.84±0.01kg were allotted to five dietary treatments in a completely randomized design with nine rabbits per treatment. The

experimental animals were housed in individual cages. Prior to the commencement of the experiment, the rabbits were treated against ecto and endo-parasites.

Watermelon rind was collected from different fruit markets in Ibadan such as Oje and Bodija markets. The samples were thoroughly washed to remove sand particles. The watermelon rinds were sliced to smaller pieces using knife, then ground into a paste form, and mixed with wheat offal as absorbent at ratio of 1:1 (25kg to 25kg) and then sun-dried for 3 days. All the processed watermelon waste with wheat offal in 1:1 were mixed together, and samples were taken for proximate analysis, in order to have consistent nutrient values. The sample was stored in an air tight container prior to mixing with other feed ingredients and used in formulation of the rabbit diets. The five experimental diets formulated were: T<sub>1</sub> – Without watermelon rind and wheat offal, T<sub>2</sub> – 10% inclusion of watermelon rind and wheat offal, T<sub>3</sub> – 20% inclusion of watermelon rind and wheat offal, T<sub>4</sub> - 30% inclusion of watermelon rind and wheat offal and T<sub>5</sub> - 40% inclusion of watermelon rind and wheat offal (Table 1). The diets were fed to the rabbits on dry matter basis at 4% of their body weight.

**Table 1: Gross composition of watermelon rind-wheat offal based experimental diets fed to Hyla rabbits**

Ingredient	T <sub>1</sub> (0%)	T <sub>2</sub> (10%)	T <sub>3</sub> (20%)	T <sub>4</sub> (30%)	T <sub>5</sub> (40%)
Maize	40.00	30.00	20.00	10.00	0.00
Watermelon rind-wheat offal mix	0.00	10.00	20.00	30.00	40.00
Soya bean meal	5.50	5.50	5.50	5.50	5.50
Palm kernel cake	30.00	30.00	30.00	30.00	30.00
Groundnut cake	5.00	5.00	5.00	5.00	5.00
Rice bran	12.00	12.00	12.00	12.00	12.00
Fish meal	3.00	3.00	3.00	3.00	3.00
Bone meal	2.00	2.00	2.00	2.00	2.00
Salt	2.00	2.00	2.00	2.00	2.00
Lysine	0.25	0.25	0.25	0.25	0.25

Methionine	0.25	0.25	0.25	0.25	0.25
<b>Total</b>	<b>100</b>	<b>100</b>	<b>100</b>	<b>100</b>	<b>100</b>

T<sub>1</sub> – Without watermelon rind and wheat offal; T<sub>2</sub> – 10% inclusion of watermelon rind and wheat offal; T<sub>3</sub> – 20% inclusion of watermelon rind and wheat offal; T<sub>4</sub> - 30% inclusion of watermelon rind and wheat offal; T<sub>5</sub> - 40% inclusion of watermelon rind and wheat offal

At the end of the experiment, feed was withdrawn for 12 hours from the rabbits so as to empty their gastro-intestinal tracts before slaughtering as described by Akinmutimi and Osuagwu (2008) and to reduce the variability in body weight due to intestinal contents. Prior to slaughtering, the rabbits were weighed; each rabbit was stunned by hand blow at the base of the neck and slaughtered by severing the jugular veins according to (Shaahu *et al.*, 2014) and bled under gravity by hanging through their hind limb using wire net. The carcass weight and dressing percentage were determined and recorded. The carcass lengths were cut as described by Igwebuikwe *et al.* (2013) into the following carcass parts (yield); fore-limb, hind-limb, head, neck, loin, back, head and tail) and then weighed with a sensitive electronic weighing scale. The weight of the liver, kidney and lung was also taken. Individual weight was noted for each rabbit and then expressed as percentage of live weight.

Histopathological investigation of liver and kidney tissues were done at the end of the experiment as reported by Avwioro (2010). Small pieces of liver and renal tissues were collected in 10 % formalin (pH 7.4) for proper fixation. These tissues were thereafter processed and embedded in paraffin wax as described by Bancroft and Gamble (2008). The formalinized tissues were dehydrated in 4 grades of alcohol, cleared in 3 xylene grades and embedded in molten wax. The embedded tissues were then trimmed into blocks and 5µm tissue samples were sectioned from the blocks using a microtome. The sections were floated in a water bath and incubated at 60°C for 30 minutes. Staining was carried out by first

clearing the section in 3 grades of xylene and rehydrating in 2 grades of alcohol. The sections were put into water and stained with hematoxylin for 15 minutes. Bluing was done with Ammonium chloride; differentiation in 1% acid alcohol was done before counterstaining with eosin. The stained slides were then mounted on glass slides using DPX (Distrene, Plasticiser and Xylene) a non-aqueous permanent mountant. The slides were observed under different magnifications with a digital microscope and results interpreted by a pathologist.

Proximate composition of the diets/treatments was determined by the procedure described by AOAC (2000). All data obtained for carcass characteristics were subjected to Analysis of Variance (ANOVA) using SAS version 9.3.1 and Duncan’s multiple range tests were used to detect significant differences among means.

### Results and discussion

Table 2 shows the proximate composition of the processed watermelon rind with wheat offal (WRWO). The WRWO had dry matter, crude protein, crude fibre, nitrogen free extracts and total ash contents of 94.66%, 18.62%, 2.66%, 53.46% and 4.85%, respectively. The crude protein value obtained for the watermelon rind with wheat offal (WRWO) is within 17 - 20% reported by Lebas *et al.* (1997). Table 3 shows the proximate composition of the experimental diets. The results showed that there were significant differences (P<0.05) in the dry matter, crude protein, crude fibre, nitrogen free extract (NFE) and total ash contents of the experimental diets. The dry matter of the experimental diet ranged from 84.95-90.265%, crude protein (12.46-16.08%), crude fibre

(7.05-8.30%), nitrogen free extract (41.02-53.89%) and total ash (7.28-13.87%). Furthermore, 10% inclusion of watermelon rind (T<sub>2</sub>) had the highest value of moisture content, 30% inclusion of watermelon waste (T<sub>4</sub>) had the highest value of crude protein, 0% inclusion of watermelon rind (T<sub>1</sub>) had the highest value of dry matter and nitrogen free extract while

40% inclusion of watermelon rind (T<sub>5</sub>) had the highest value of crude fibre and total ash. The crude protein range (12.46-16.08%) of the experimental diets was lower than 17-20% reported by Lebas *et al.* (1997); 18.38-18.68% reported by Gbenge (2022) and 19.77-20.11% reported by Igbwebuike *et al.* (2013).

**Table 2: Proximate analysis of processed watermelon rind with wheat offal (WRWO)**

Parameters (%)	Watermelon rind-wheat offal mixture
Moisture	5.34
Dry Matter	94.66
Crude Protein	18.62
Crude fibre	2.66
Nitrogen free extract	53.46
Total ash	4.85

WRWO - watermelon rind and wheat offal mix

**Table 3: Proximate analysis of experimental diets**

Parameters (%)	T1 (0%)	T2 (10%)	T3 (20%)	T4 (30%)	T5 (40%)	SEM (±)
Dry Matter	90.26 <sup>a</sup>	84.95 <sup>d</sup>	90.10 <sup>ab</sup>	89.94 <sup>b</sup>	89.59 <sup>c</sup>	0.39
Crude Protein	12.46 <sup>c</sup>	15.05 <sup>c</sup>	15.69 <sup>b</sup>	16.08 <sup>a</sup>	14.61 <sup>d</sup>	0.56
Crude fibre	7.18 <sup>cd</sup>	7.05 <sup>d</sup>	8.04 <sup>b</sup>	7.22 <sup>c</sup>	8.30 <sup>a</sup>	0.05
Nitrogen free extract	53.89 <sup>a</sup>	45.85 <sup>b</sup>	43.57 <sup>c</sup>	43.52 <sup>c</sup>	41.02 <sup>d</sup>	0.04
Total ash	7.28 <sup>d</sup>	9.30 <sup>c</sup>	9.20 <sup>c</sup>	10.95 <sup>b</sup>	13.87 <sup>a</sup>	0.11

<sup>a, b, c, d, e</sup> means of different superscripts along the same row are statistically significant (P < 0.05)

T<sub>1</sub> – Without watermelon rind and wheat offal; T<sub>2</sub> – 10% inclusion of watermelon rind and wheat offal; T<sub>3</sub> – 20% inclusion of watermelon rind and wheat offal; T<sub>4</sub> - 30% inclusion of watermelon rind and wheat offal; T<sub>5</sub> - 40% inclusion of watermelon rind and wheat offal; **SEM** (±) – Standard error of mean

Table 4 shows the carcass characteristics of Hyla rabbits fed graded levels of watermelon rind-wheat offal mix. Results showed that there were significant effect (P<0.05) of the experimental diet on the live weight and bled weight. However, there was no significant effect of the experimental diets on the percentages of skinned body weight, skin weight, eviscerated weight, dressing weight, head weight, forelimb weight, hind limb weight, neck weight, liver weight, kidney weight, lung weight and spleen weight to the live weight of the rabbits. These results were

similar to observations by Igbwebuike *et al.* (2013). The authors reported a range of 46.34 - 61.89% for dressing percentage, with no significantly (p>0.05) differences among the treatments. Rabbits on T<sub>4</sub> had the highest live weight value (2.36kg) which was significantly higher (p<0.05) than the values obtained for T<sub>1</sub> (2.08kg), T<sub>3</sub> (1.93kg), T<sub>2</sub> (1.56kg) and T<sub>5</sub> (1.10kg), respectively. Rabbits in T<sub>4</sub> had the highest value (2.02kg) for bled weight when compared to rabbits in T<sub>3</sub> (1.88kg), T<sub>1</sub> (1.73kg), T<sub>5</sub> (1.63kg) and T<sub>2</sub> (1.53kg).

**Table 4: Carcass characteristics of Hyla rabbit fed graded levels of watermelon rind-wheat offal mix**

Parameter (mean)	T <sub>1</sub> (0%)	T <sub>2</sub> (10%)	T <sub>3</sub> (20%)	T <sub>4</sub> (30%)	T <sub>5</sub> (40%)	SEM (±)
Live weight, (kg)	2.08 <sup>b</sup>	1.56 <sup>d</sup>	1.93 <sup>c</sup>	2.36 <sup>a</sup>	1.10 <sup>e</sup>	0.11
Bled weight (kg)	1.73 <sup>ab</sup>	1.53 <sup>b</sup>	1.88 <sup>ab</sup>	2.02 <sup>a</sup>	1.63 <sup>ab</sup>	0.08
% Live weight						
Skinned body weight (%)	79.00	96.18	87.91	77.45	79.69	4.64
Skin weight (%)	10.89	9.53	10.07	8.68	9.17	0.70
Eviscerated weight (%)	55.36	81.21	59.47	54.65	45.95	4.77
Dressing percentage (%)	52.59	46.34	54.18	50.40	61.89	2.01
Head weight (%)	8.65	11.27	10.68	8.36	9.07	0.62
Forelimb weight (%)	7.75	11.35	7.29	7.77	8.20	0.80
Hind limb weight (%)	19.12	23.85	21.86	19.16	19.97	1.39
Neck weight (%)	2.49	2.84	2.55	2.20	2.25	0.18
Liver weight (%)	1.59	2.89	2.20	2.13	1.82	0.19
Kidney weight (%)	0.43	0.61	0.55	0.53	0.41	0.04
Lung weight (%)	0.41	0.60	0.43	0.49	0.41	0.04
Spleen weight (%)	0.04	0.07	0.05	0.04	0.03	0.01

<sup>a, b</sup> means of different superscripts along the same row are statistically significant (P < 0.05).

T<sub>1</sub> – Without watermelon rind and wheat offal; T<sub>2</sub> – 10% inclusion of watermelon rind and wheat offal; T<sub>3</sub> – 20% inclusion of watermelon rind and wheat offal; T<sub>4</sub> - 30% inclusion of watermelon rind and wheat offal; T<sub>5</sub> - 40% inclusion of watermelon rind and wheat offal; **SEM** (±) – Standard error of mean

The percentage skinned body weight (96.18%) of T<sub>2</sub> was higher than that of T<sub>3</sub>, T<sub>5</sub>, T<sub>1</sub> and T<sub>4</sub> with 87.91%, 79.69%, 79.00% and 77.45%, respectively. This observed difference in carcass composition in this study could be attributed to the differences in the rabbit genetic origin, adult body weight, maturity at slaughter, environment, diet, rearing system and other factors according to the reports of (Tumova *et al.*, 2014; Kumar *et al.*, 2023).

Table 5 shows the histopathological changes observed in the kidneys and livers of Hyla

rabbit fed graded of watermelon rind-wheat offal mix. Histopathology is the study of changes in any tissue associated with a disease or disorder. This can be very useful in making a diagnosis and determination of the severity and progression of a disease in animals (Titfore, 2006). Adverse histopathological changes in the tissue of an animal can be due to increase in nitrate concentration and high levels of phytochemicals in the diets. There were no observable lesions seen in the kidney of experimental rabbits fed 0%, 10%, 20%, 30% and 40% WRWO.

**Table 5: Histopathological changes in the kidneys and livers of Hyla rabbit fed graded levels of watermelon rind-wheat offal mix**

Tissue	T <sub>1</sub> (0%)	T <sub>2</sub> (10%)	T <sub>3</sub> (20%)	T <sub>4</sub> (30%)	T <sub>5</sub> (40%)
Kidney	No visible lesion	No visible lesion	No visible lesion	No visible lesion	No visible lesion

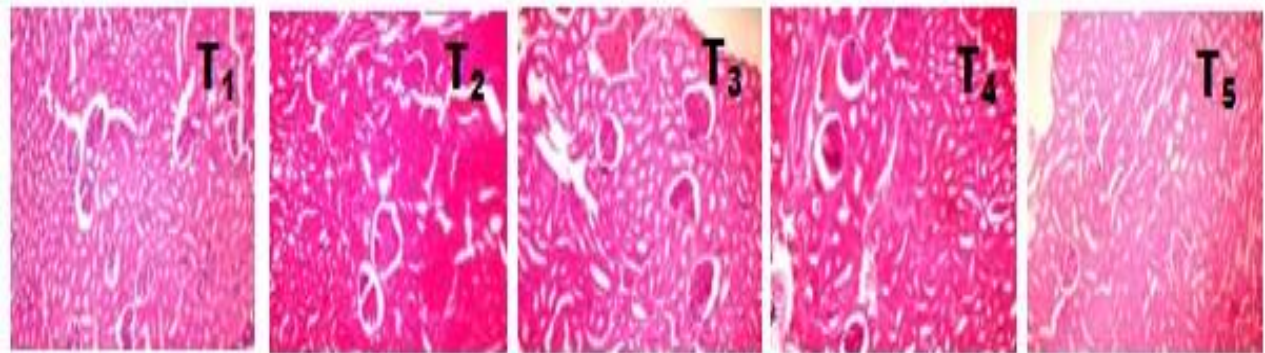
*Carcass characteristics and hepato-histopathological examination of Hyla rabbit fed graded levels of watermelon rind-wheat offal mix*

Liver	Focal lymphoid aggregate, mild steatosis and congestion	area of disseminated and mild	No visible lesion	Mild disseminated steatosis and focal periportal infiltration	Moderate disseminated microvesicular steatosis	Very mild disseminated microvesicular steatosis, portal fibrosis, focal congestion and mild periportal infiltration by inflammatory cells
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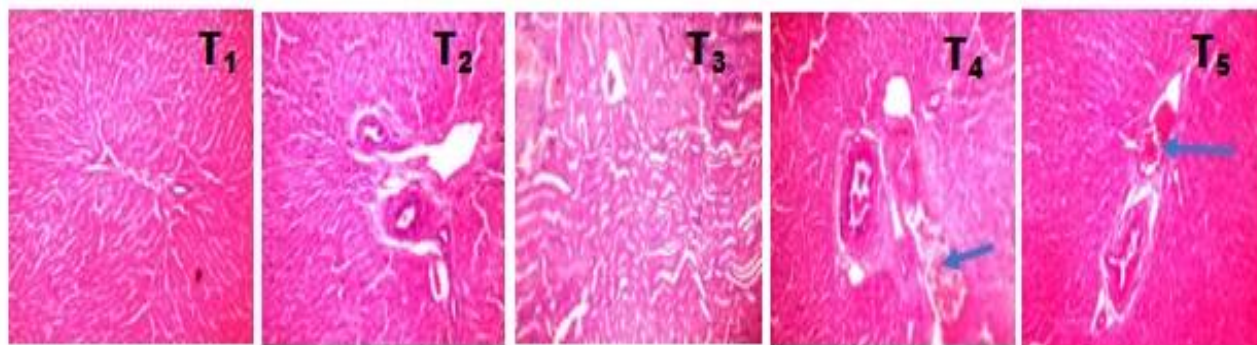
T<sub>1</sub> – Without watermelon rind and wheat offal; T<sub>2</sub> – 10% inclusion of watermelon rind and wheat offal; T<sub>3</sub> – 20% inclusion of watermelon rind and wheat offal; T<sub>4</sub> - 30% inclusion of watermelon rind and wheat offal; T<sub>5</sub> - 40% inclusion of watermelon rind and wheat offal

Mild disseminated steatosis were observed in the livers of the rabbits fed 0%, 20%, 30% and 40% WRWO while there was no visible lesion in the liver of rabbits fed 10% WRWO. Rabbits fed 40% WRWO showed portal fibrosis and focal congestion. Figure 1 and 2 below shows the photomicrographs of the kidneys and livers of Hyla rabbit fed graded levels of watermelon

rind-wheat offal mix. Plates of the treatments showed no significant observable lesion in figure 1. In figure 2, T<sub>1</sub>, T<sub>2</sub> and T<sub>3</sub> plates showed no significant observable lesion; T<sub>4</sub> plate showed mild disseminated congestion (arrow), while T<sub>5</sub> showed very mild focal congestion (arrow).



**Figure 1: Photomicrographs of the kidney sections of the experimental animals**



**Figure 2. Photomicrographs of the liver sections of the experimental animals**

The mild disseminated congestion and mild focal disseminated congestion observed in T4 and T5, respectively in Figure 2 is an indication that if the level of WRWO is not limited to 40%, the disseminated congestion might become severe, and the continuous feeding of the diet can lead to or be risk factor for architectural disruption of their liver tissue.

#### **Conclusion**

Based on the results, watermelon rind-wheat offal mix can be included in the diets of Hyla rabbits up to 40% without adverse effect on their carcass characteristics and hepato-histopathological examination.

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