EFFECTS OF NUTRITION ON HAEMATOLOGY OF RABBITS: A REVIEW

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Abstract
This review examined the effects of nutrition on haematology of rabbits. The physiology of farm animals is influenced by several factors, one of which is nutrition. The nutritional status of an animal is dependent on dietary intake and effectiveness of metabolic processes. Dietary contents affect blood profile of farm animals. Haematological studies represent a useful process in the investigation of the extent of damage to the blood. Examination of blood provides the opportunity to clinically investigate the physiological, nutritional and pathological status of an animal. And changes in haematological parameters are often used to determine stresses due to nutrition. Reports by different researchers indicated that different diets fed to rabbits had different effects on haematological parameters, some of which were detrimental while others improved their haematological indices as they remained within the normal range of values for rabbits.

Keywords: Effects, nutrition, haematology, farm animals

Introduction
The physiology of farm animals is affected by several factors, one of which is nutrition (Ajao et al., 2013). Nutritional status of an individual is dependent on dietary intake and effectiveness of metabolic processes. These
can be determined by either or combinations of chemical, anthropometric, biochemical or dietary methods (Bamishaiye et al., 2009). Feed is an important aspect of livestock production. The importance of feed supplementation in animal production has increased in the last few years (Sharifi et al., 2011). Increase in meat production can be achieved through proper nutrition, inclusion of feed ingredients at normal or required levels (Etim and Oguike, 2010). According to Schalm et al. (1975) blood pictures of animals might be influenced by certain factors, one of which is nutrition. Swenson (1970) and Addass et al. (2012) posited that nutrition affects blood values of animals. Dukes (1955) also documented that haematological values of farm animals are influenced by nutritional status. Processing of feed could have effect on haematological parameters of farm animals (Aya et al., 2013). Dietary content affect the blood profile of healthy animals (Odunsi et al., 1999; Yeong, 1999; Iheukwumere and Herbert, 2002; Kortuglu et al., 2005). Isaac et al. (2013) stated that haematological components, which consists of red blood cells, white blood cells or leucocytes, Mean Corpuscular Haemoglobin and Mean Corpuscular Haemoglobin Concentration are valuable in monitoring feed toxicity, especially, with feed constituents that affect the blood as well as the health status of farm animals. Aro and Akinmoegun (2012) and Aro et al. (2013) reported that haematological parameters like haematocrit value, haemoglobin concentration, white blood cell count, red blood cell count among others are used in routine screening for the health and physiological status of livestock and even humans. Adejumo (2004) reported that haematological traits especially Packed Cell Volume (PCV) and Haemoglobin (Hb) were correlated with the nutritional status of the animal. Isaac et al. (2013) stated that PCV is involved in transport of oxygen and absorbed nutrient. Other blood parameters like blood viscosity are often neglected in routine clinical and physiological investigations. Blood viscosities are however, also affected by nutrition, especially, when processed agro-industrial wastes are taken into consideration. Livestock blood, for instance, may be subjected to hyperviscosity syndrome consequent on the feed they consume which may ultimately affect other blood values like haematocrit and erythrocyte sedimentation rate (Rosencranz and Bogen, 2006; Aro et al., 2013). Blood viscosity can also help to unravel clinical case of blood abnormalities like polycythemia and reduced plasma volume (Jain, 1993; Aro and Akinmoegun, 2012).

Many feed products are fed to rabbits usually without recourse to their health and physiological implications on the animals. The commonest parameter for measuring these implications is through the haematology of the animals (Aro et al., 2013). Moreover, the comparison of blood profile
with nutrient intake might indicate the need for adjustment of certain
nutrients upward or downward for rabbits (Rafiu et al., 2013).

Thus, this review examined the effect of nutrition on haematology of
rabbits.

2. Haematological Studies

Haematological studies have been found useful for disease prognosis
and for the therapeutic and feed stress monitoring (Togun and Oseni, 2005).
Haematological studies are important because the blood is the major
transport system of the body, and evaluations of the haematological profile
usually furnishes vital information on the body’s response to injury of all
forms, including toxic injury (Schalm et al., 1975; Coles, 1986; Ihedioha et
al., 2004). Haematological studies represent a useful process in the diagnosis
of many diseases as well as investigation of the extent of damage to the
blood (Onyeyili et al., 1991). This is relevant since blood constituents’
change in relation to the physiological conditions of animals. The blood
transports or conveys nutrient and materials to different parts of the body.
Therefore, whatever affects the blood; either drugs, pathogenic organism or
nutrition will certainly affect the entire body adversely or moderately in
terms of health, growth, maintenance and reproduction (Oke et al., 2007;
Etim, 2010). A readily available and fast means of assessing clinical and
nutritional health status of animals on feeding trials may be the use of blood
analysis, because ingestion of dietary components have measurable effects
on blood composition (Church et al., 1984; Maxwell et al., 1990) and may
be considered as appropriate measure of long term nutritional status
(Olabanji et al., 2007).

(a) Examination of Blood

The examination of blood provides the opportunity to clinically
investigate the presence of several metabolites and other constituents in the
body and it plays a vital role in the physiological, nutritional and
pathological status of the animal (Aderemi, 2004; Doyle, 2006). It also helps
to distinguish normal state from state of stress which can be nutritional
(Aderemi, 2004). Haematological parameters are good indicators of the
physiological status of animals (Hawkey and Dennett, 1989; Adenkola and
Durotoye, 2004; Khan and Zafar, 2005). They are also excellent medium for
the measurement of potential biomarkers, because its collection is relatively
non-invasive and it encompasses an enormous range of physiological process
in the body at any given time (Ginsbury and Haga, 2006). Haematological
constituents reflect the physiological responsiveness of the animal to its
internal and external environments which include feed and feeding (Esopnu
et al., 2001). According to Daramola et al. (2005), haematological values
could serve as a baseline information for comparisons of nutrient deficiency,
physiology and health status of farm animals. Radostits (1994) posited that low nutritional pastures among other factors alter the blood values of sheep and goats. As reported by Adejumo (2004), haematological traits, especially, PCV and Hb were correlated with the nutritional status of the animal. Adamu et al. (2006) observed that nutrition had significant effect on haematological values like PCV, Hb and RBC. Togun et al. (2007) reported that increase in PCV coupled with the marginal increase in RBC is indicative of more efficient erythropoiesis in experimental rabbits.

(b) Changes in Haematological Parameters

Changes in haematological parameters are of value in assessing the responses of animals to various physiological and disease conditions (Schalm et al., 1975; Yadav et al., 2002; Khan and zafar, 2005). Changes in haematological parameters are often used to determine stresses due to nutrition and other factors (Afolabi et al., 2010). Chineke et al. (2006) also reported that apart from genotype, age and sex, differences in haematological indices may be caused by nutritional factor. Great variation has been observed in the haematological parameters between breeds of farm animals (Tambuwal et al., 2002), in this regard, it may be difficult to formulate a universal metabolic profile test for animals. These differences have underlined the need to establish appropriate physiological baseline values for various breeds of livestock in Nigeria which could help in realistic evaluation of nutrition and diagnosis of health condition (Daramola et al., 2005).

3. Effects Of Different Diets On Haematology Of Rabbits

A study was conducted by Olayinka et al. (2010) on the haematology indices of weaned rabbit fed loofah gourd (Luffa aegyptiaca) seed meal (LGSM) at 0%, 5%, 10% and 15%. Haematological parameters such as the Haemoglobin (Hb), Packed Cell Volume (PCV), White Blood Cell Count (WBC) and Red Blood Cell Count (RBC) were monitored. Olayinka et al. (2010) stated that 5% LGSM can be included in the diets of rabbits without any serious adverse effect on their haematological characteristics. Olafadehan et al. (2010) carried out a study on the effect of residual cyanide in processed cassava peel meal on haematological indices of growing rabbits and observed that with exception of neutrophil and eosinophil, other haematological parameters were significantly affected by the dietary treatments. An experiment was also carried out by Lawrence-Azua et al. (2013) on the haematological indices of growing rabbits fed enzyme supplemented cocoa bean shell. Four dietary treatments were formulated to contain 0%, 10%, 20% and 30% of cocoa bean shell as a replacement for maize. The result revealed significant differences in values obtained for white blood cells. Lawrence-Azua et al. (2013) stated that enzyme treated
cocoa bean shell can be included in rabbits diet upto 30% inclusion levels without any detrimental effect on their haematological indices.

Another study was carried out by Ewuola et al. (2010) on haematology of weaned rabbits fed dietary prebiotics (Biotronic®) and probiotics (BioVET®-Yc) at the recommended rates of 500g/tone and 4kg/tone respectively. The control diet had neither probiotic nor pre-biotic while prebiotic, probiotic and symbiotic (prebiotic + probiotic) was added at the recommended rates to diets 2, 3 and 4 respectively. Results showed that the erythrocytes and leukocytes of the rabbits were not significantly affected by the dietary treatments. The haemoglobin of the rabbits on diets 3 and 4 were significantly the same, with the control and higher than those of 2. The PCV was significantly higher in rabbits fed diets 3 and 4 compared to those on diet 2. The MCV and MCH of the rabbits fed diets 3 and 4 were significantly higher than those on the control diet while MCHC was significantly affected by the diets. Jiya et al. (2008) in a study on effect of replacing fish meal with silkworm caterpillar (Anapheinfracta) on the haematological parameters of weaned rabbits observed differences in PCV, RBC and WBC which they stated were common in domestic animals and rabbits and suggested that the differences were due to gradual increase in Hb, RBC and PCV concentration after birth which continued until adult stage.

(a) **Haematological values of Rabbits and their Significance**

Mitruka and Rawnsley (1977) reported that the normal ranges of value for rabbits are as follows: PCV: 30 – 35%, Hb: 9.3 – 19.3g/dl and RBC: 4.00 – 8.60×10^6/mm^3). According to Togun et al. (2007), when the haematological values fall within the normal range reported for rabbits by Mitruka and Rawnsley (1977), it is an indication that the diets did not show any adverse effects on haematological parameters during the experimental period, but when the values fall below the normal range, it is an indication of anaemia (Mitruka and Rawnsley, 1977; Radostits, 1994; Ameen et al., 2007). Low haematological values such as 30% Packed Cell Volume (PCV), Haemoglobin Concentration (Hb) of 10.30g/dl and Red Blood Cell (RBC) counts of 7.10 x 10^6/ml as reported by Bawala et al. (2007) could be due to the harmful effects of high dietary content. Differences observed in Packed Cell Volume (PCV) and MCV for animals in different treatment groups may be attributed to the physiological and nutritional status of the animals (Esonu et al., 2001). Higher WBC count may explain the reason for disease resistance which has been reported by Nwosu (1979) or the prevalence of disease condition. It may also explain longevity as reported by Mbanasor et al. (2003). Lower than normal White Blood Cells (WBC) count suggests a greater challenge to the immune system of rabbits. Ehoba et al. (2008) noted that a decrease in WBC count, however, reflected a fall in the production of defensive mechanism to combat infection. Togun et al. (2007) reported that a
significantly lower lymphocyte count was an indication of a reduction in the ability of the experimental rabbits to produce and release antibiotics when infections occur (Campbell and Lasley, 1975). White Blood Cells Count (WBC) of 5 – 13 (x10^9/l) is considered to be within normal range according to Burke (1994). Furthermore, Poole (1987) reported a PCV range of 30 – 50%. Anon (1980) documented mean values for rabbits as shown below.

**Table 1: Haematological Values for Rabbits**

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>PCV (%)</td>
<td>31.0 – 51.0</td>
</tr>
<tr>
<td>RBC (x10^6/mm³)</td>
<td>5.0 – 8.0</td>
</tr>
<tr>
<td>WBC (x10^3/mm³)</td>
<td>3.0 – 12.5</td>
</tr>
<tr>
<td>Hb (g/dl)</td>
<td>8.0 – 17.0</td>
</tr>
</tbody>
</table>

**Source:** Anon (1980)

Olabanji *et al.* (2007) recorded the following mean values for rabbits.

**Table 2: Haematological Values of Rabbit**

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hb (g/dl)</td>
<td>7.02 ± 1.21 – 9.92 ± 0.58</td>
</tr>
<tr>
<td>PCV (%)</td>
<td>21.0 ± 3.53 – 30.0 ± 1.84</td>
</tr>
<tr>
<td>RBC (x10^6/mm³)</td>
<td>3.53 ± 0.57 – 5.05 ± 0.31</td>
</tr>
<tr>
<td>MCV (fl)</td>
<td>59.4 ± 0.67 – 59.8 ± 0.34</td>
</tr>
<tr>
<td>MCH (pg)</td>
<td>19.7 ± 0.03 – 19.8 ± 0.24</td>
</tr>
<tr>
<td>MCHC (g/dl)</td>
<td>33.1 ± 0.15 – 33.3 ± 0.49</td>
</tr>
<tr>
<td>WBC (x10^3/mm³)</td>
<td>4.68 ± 0.36 – 5.9 ± 0.69</td>
</tr>
<tr>
<td>Neutrophils (%)</td>
<td>32.17 ± 1.82 – 34.5 ± 1.80</td>
</tr>
<tr>
<td>Lymphocytes (%)</td>
<td>52.17 ± 1.71 – 59.3 ± 1.28</td>
</tr>
<tr>
<td>Monocytes (%)</td>
<td>0.67 ± 0.21 – 1.50 ± 0.34</td>
</tr>
<tr>
<td>Eosinophils (%)</td>
<td>0</td>
</tr>
</tbody>
</table>

**Source:** Olabanji *et al.* (2007)

According to Olabanji *et al.* (2007) the values for all the parameters fall within the normal range established by Mitruka and Rawnsley (1977) for rabbits. Oyebi *et al.* (2007) reported mean values of 3.80 ± 0.23 – 4.13 ± 0.61 for White Blood Cells (WBC) (x10^3/mm³) and stated that they were lower than the normal range of values reported by Mitruka and Rawnsley (1977). Post Graduate Committee on Veterinary Sciences (PGCVS) (1990) reported a standard WBC range of 2.5 – 12.5 (x10^3/mm³). Reilly (1993) opined that normal range of values for WBC indicated that the animals were healthy because decrease in number of WBC below the normal range is an indication of allergic conditions, anaphylactic shock and certain parasitism.

Togun *et al.* (2007) recorded mean values for rabbits as shown in Table 3.

**Table 3: Haematological Values of Rabbits**

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>PCV (%)</td>
<td>40.0 – 40.2</td>
</tr>
<tr>
<td>Hb (g/dl)</td>
<td>13.2 – 13.4</td>
</tr>
<tr>
<td>RBC (x10^6/mm³)</td>
<td>6.65 – 6.68</td>
</tr>
<tr>
<td>WBC (x10^3/mm³)</td>
<td>8.72 – 9.56</td>
</tr>
</tbody>
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| 418 |
Polymorphs (%)  64.8 – 67.4  
Lymphocytes (%)  31.6 – 33.8  
Monocytes (%)  0.6 – 1.4  
MCV (N\(^3\))  60.15 – 60.18  
MCH (Pg)  19.85 – 20.06  
MCHC (%)  3.30 – 3.33  

Source: Togun et al. (2007)

Togun et al. (2007) stated that the observed values for haematological parameters in their study fell within the normal range reported for rabbits by Mitruka and Rawnsley (1977). They further stated that; it was an indication that the experimental diets (Pigean pea; Cajanus cajan) grain or leaf meal did not have any detrimental effects on haematological parameters during the experimental period.

Schalm et al. (1975) reported a normal PCV range of 31 – 50%. Harkness and Wagner (1989) reported a RBC range of 4.8 – 6.3 \(x10^6\)/mm\(^3\). Brown et al. (2000) opined that increased RBC values are associated with high quality dietary protein and with disease free animals. PGCVS (1990) reported a normal range of values for Hb of 8 – 17g/dl. Normal range of values for Hb indicated that the vital physiological relationship of haemoglobin with oxygen in the transport of gases (oxygen and carbon dioxide) to and from the tissues of the body has been maintained and was normal (Njidda et al., 2006). According to Isaac et al. (2013) Packed Cell Volume is involved in the transport of oxygen and absorbed nutrients. Njidda et al. (2006) posited that MCV, MCH and MCHC are used in diagnosing anaemic conditions. Ahmed et al. (1994) observed that MCHC values decrease with increase in the level of protein.

Conclusion
Dietary contents influence the blood profile of rabbits. Haematological studies represent a useful tool in assessing the effects of different diets on blood parameters of farm animals and haematological values of farm animals are influenced by the nutritional status of the animals under consideration.

References:


