Hematological impact in mice due to alteration in their nutritional style

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Abstract:

It is well established that alteration of diet style from plant-based to fat-rich diet lead to many complications including cardiovascular disease, metabolic syndrome, osteoporosis, and as well as anemia. According to our previous researches, changing in nutritional style from a conventional diet to fat-rich diet caused disturbance in the histology and function of different organs. So this work aims to study the effect of transition from a completely plant-based diet to 10% animal products on different hematology parameters in mice by using two groups of adult male Balb/c mice (n=8 mice for each). The first group represents restricted group that fed on conventional diet containing 10% sheep brain homogenate, while the second group represents control group that fed ad libitum on conventional diet only. The mice were sacrificed by cervical dislocation after 7 days. Blood samples were collected from the eyes in sterile tubes and immediately used to determine complete blood count (CBC). The results showed that platelets count, platelets/Lymphocytes ratio, and the total count of white blood cells particularly monocytes in restricted group are significantly higher than those in control group. However, Red blood cells RBCs, hemoglobin concentration, hematocrit, RDW-SD level are significantly lower in restricted group in comparison with those of control group. In conclusion, these results indicate that nutritional style alteration can affect cellular elements of blood and may provoke anemia, thromboembolism and immune response which need further investigation.

Key words: Nutritional style, RBC indices, anemia, platelet/lymphocyte ratio

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Introduction:

Research conducted in the past decade revealed that changes from a diet rich-fiber and low-fat to a diet low-fiber and rich-saturated fat cause the obesity development, cardiovascular disease and metabolic syndrome (1, 2) and lead to many complications including osteoporosis, anemia, etc. (3). The fatty acids incorporation plays an important role in the structure and function of the plasma membrane (4), and thus the activity of the membrane protein (5-7). It has been linked to the occurrence of infections, metabolic diseases, and other human disorders (8, 9). RBC membranes are affected by long-term fatty acid intake compared to other tissues (10). In addition, there is a relationship between white blood cell count (WBC) and cardiovascular disease (11) that may result from consuming a high-fat diet. Several epidemiological studies have consistently shown a significant relationship between white blood cell count (WBC) and the incidence of coronary heart disease and stroke (12). As well as, the correlation between WBC count and inflammation which could be caused by the changing from a diet rich-fiber and low-fat to a diet low-fiber and rich-saturated fat (13). On the other hand, Activation, and aggregation of platelets are among the main processes that are usually controlled in the pathophysiology of coronary heart disease, where the average size of the platelets increases in acute myocardial infarction, acute stroke, preeclampsia and narrowing of the renal artery (14).

According our previously researches, changing in nutritional style rather than a conventional diet caused pathological effects on the histology and physiology of different organs (13, 15). So this work aims to study the...
effect of transition from a completely plant-based diet to 10% animal products on different hematology parameters in mice.

**Material and Methods**

In this study, 16 adult male Balb/c mice were conducted. The age of these mice was 8 week-old. They were obtained from our animal house in our college. The mice divided into two groups. The first one, 8 mice consumed 10% sheep brain (restricted group). The second, 8 mice consumed the normal diet ad libitum (control group). The mice were sacrificed by cervical dislocation after 7 days. After removal of the eyeball by forceps, blood samples were collected from the eyes in sterile tubes and immediately used to determine different hematology parameters by CBC test using D-Cell 60 Hematology Analyzer from DIAGON®/Diagon Ltd, Hungary, Budapest. Data are expressed as mean ± standard deviation (M±SD) and analyzed by using Statview version 5.0 based on T-Test. Differences considered significant at P. value less than 0.05.

**Results**

Table-1 shows the different between total white blood cells indices in the restricted and control groups. There were significantly (P < 0.05) increase in the total WBCs and Monocytes number were significantly higher in the restricted group (13.5 ± 5.8 x 10^9/L and 2.4 ± 0.6 x 10^9/L, respectively) compared to control (10.1 ± 2.7 x 10^9/L and 0.7 ± 0.2 x 10^9/L, respectively) while there was no significantly difference between the other white blood cells types.

Table-1: White blood cells indices in the restricted and control groups

<table>
<thead>
<tr>
<th>Groups</th>
<th>White blood cell indices x 10^9/L</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Total WBC</td>
</tr>
<tr>
<td>Restricted</td>
<td>13.5 ± 5.8*</td>
</tr>
<tr>
<td>Control</td>
<td>10.1 ± 2.7</td>
</tr>
<tr>
<td>Normal Value^16</td>
<td>4.45 -13.98</td>
</tr>
</tbody>
</table>

*Significant differences between restricted vs. control groups.

RBCs count, Hb level, hematocrit, and RDW-SD level decreased significantly (P<0.05) from (8.5 ± 1.3 x 10^12/L, 13.03± 1.9 g/dl, 40.6% ± 7.6%, and 34.5 ± 4.2 fl., respectively) in control group down to (6.01± 0.7 x 10^12/L, 9.0 ± 1.2 g/dl, 27.7% ± 3.2%, and 29.6 ± 1.3 fl., respectively) in restricted group which were lower than normal value (16) (7.14 -12.2 x 10^12/L, 10.8 – 19.2 g/dl, and 37.3% – 62%, respectively). There was no significant deference in the other red blood cells indices between these groups (Table-2).

Table-2: RBC indices in the restricted and control groups

<table>
<thead>
<tr>
<th>Groups</th>
<th>Red blood cells indices</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>RBC x10^12/L</td>
</tr>
<tr>
<td>Restricted</td>
<td>6.01± 0.7*</td>
</tr>
<tr>
<td>Control</td>
<td>8.5 ± 1.3</td>
</tr>
<tr>
<td>Normal value^16</td>
<td>7.14 -12.20</td>
</tr>
</tbody>
</table>

*Significant differences between restricted vs. control groups.
Platelets count and platelets/lymphocytes ratio increase from \((978 \pm 89 \times 10^9/L\) and \(132 \pm 9.9\), respectively) in control group to \((1999 \pm 777 \times 10^9/L\) and \(331.9 \pm 14.6\), respectively) in the restricted group. Platelets/lymphocytes ratio in restricted group was about three times more than control group and platelets count in the restricted group was also critical compared to normal value \((841 – 2156 \times 10^9/L)\). (Table-3)

**Table-3: Platelet indices levels in the restricted and control groups**

<table>
<thead>
<tr>
<th>Groups</th>
<th>Platelets Indices</th>
<th>Platelets / Lymphocytes Ratio</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>PLT x 10^9/L</td>
<td>MPV</td>
</tr>
<tr>
<td>Restricted</td>
<td>1999 ± 777*</td>
<td>6.1 ± 0.3</td>
</tr>
<tr>
<td>Control</td>
<td>978 ± 89</td>
<td>7.4 ± 0.7</td>
</tr>
<tr>
<td>Normal value</td>
<td>841 - 2156</td>
<td>NA</td>
</tr>
</tbody>
</table>

*Significant differences between restricted vs. control groups.
Platelets (PLT), mean PLT volume (MPV), PLT distribution width (PDW), not available (NA)

**Discussion**

The alteration of mice’s diet style from Plant-based into fat-rich diet could cause many pathological effects in many body organs that provoke an immune response in these organs (13, 15). A diet rich in saturated fatty acids is thought to stimulate a low degree of chronic inflammation (17) and may not only lead to increased levels of serum inflammatory mediators but also the apoptosis process (18). Our present research shows that the total WBCs and Monocytes number increased abnormally in the restricted group. It is well established that any immune response could increase the total WBCs and high monocyte concentration can be associated with increased phagocytosis to get rid of strange and toxic substances (19). Our findings regarding monocyte concentration are consistent with previous studies (20-22).

Our results show a significant reduction in the Hb, hematocrit, RBCs, and RDW-SD which could cause either microcytic anemia (23) or hemolytic anemia (24). Since our results reported an insignificant difference in the MCV, the type of anemia could be hemolytic, not microcytic (25). Liao et al demonstrated that high-fat feeding significantly increased plasma free cholesterol levels and induced spontaneous hemolysis (26). In addition, the high cholesterol resulted in an increase in erythrocyte osmotic fragility which caused the development of hemolytic anemia in cholesterol-fed rabbits (27). An increase in oxidative stress has also been suggested as a cause of the hemolytic anemia which was seen following a high cholesterol diet (27) which agreed with our results where platelet/lymphocytes ration was three-time more than the control group. Platelet/lymphocytes ratio is used as one of the important markers for oxidative stress (28, 29). Furthermore, researchers reported that oxidative stress following high-fat diet feeding which could be closely associated with cognitive impairment, brain proinflammatory cytokine production, and astrocyte activation (30-32)

Our results shows that the high rate of fat could cause thrombocytosis since it reported elevated in Platelets count in the restricted group compared to control. It is known that eating dietary fats can alter the concentration of lipoproteins in plasma. Saturated fatty acids have a strong hyper cholesterol effect (33). Therefore, some of the effects of dietary fats, especially saturated fats, can mediate platelet aggregation by affecting plasma lipid concentrations which increase arterial thrombosis tendency in the rat. In vitro, platelet aggregation measurements showed that farmers consuming large amounts of dairy fat had a high response to thrombin compared to farmers who mainly used vegetable oil (34). On the other hand, the relationship between high cholesterol and hematopoiesis was previously suggested. High cholesterol in the blood increases the recruitment/mobilization of macrophages and their activation in atherosclerosis, for example, (35-37). Moreover, High cholesterol in the blood is associated with increased peripheral white blood cell count and increased platelet levels, generally due to the cholesterol-induced cytokines (38).
It can be concluded that the changing in nutritional style rather than a conventional diet caused monocytosis to ensure phagocytic activity, hemolytic anemia by increased red blood cell fragility and oxidative fragility, as well as thrombocytosis that may enhance coagulation process leading to thromboembolism.

References:


