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Curcuma longa and *Punica granatum* Restore Weight Dysregulation and Hematological Alterations in Wistar Rats Fed Thermally Oxidized Oil

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ABSTRACT
Thermal abuse of oils has been linked to various health complications, including weight dysregulation and hematological alterations. This study aimed to investigate the potential restorative effects of turmeric and pomegranate supplementation on these disturbances in rats exposed to thermally abused oil. A total of 40 female rats were divided into eight (8) groups; a control group, a group exposed to thermally abused oil, three groups received supplementation of turmeric and/or pomegranate and three groups received a thermally abused oil-based diet supplemented with turmeric and/or pomegranate. The weight of rats was measured weekly and average weights were used for assessment of weight dysregulation. Hematological parameters, including WBC, lymphocytes, monocytes, neutrophils, eosinophil basophils, platelets and PVC were assessed using automated hematological analyzer. The result showed that turmeric and/or pomegranate restored normal weights in rats fed thermally abused oil (67.4%, 78.6% and 49.6% for the treatment groups compared to 98.6% of the thermally abused oil based diet group). The results also showed significant improvement ($p<0.05$) in the hematological parameters in the supplemented groups compared to the group exposed to thermally abused oil alone.. The study highlights the potentials of these natural supplements in mitigating oil-induced toxicity and promoting health in toxicological conditions.

Keywords:
Thermally-abused oil, hematological indices, *Curcuma lomga*, *Punica granatum*.

INTRODUCTION

The increasing consumption of cooking oils, particularly those subjected to high temperature during repeated use, has raised significant concerns regarding their potential health hazards (Grootveld *et al*., 2020). Thermal abuse of cooking oil-such as in deep frying and prolonged heating-can result in the formation of harmful compounds like aldehydes, free radicals and oxidized lipids, which are detrimental to human health (Singh, 2013). These toxic by-products have been implicated in various pathophysiological conditions, including oxidative stress, inflammation and even cancer (Zahra *et al*., 2021). The long-term exposure to thermally abused oils can impair hematological functions, provoke inflammatory responses, and promote tumorigenesis, ultimately leading to several chronic diseases and compromising overall health (Oyirifi, 2024).

In particular, rats exposed to thermally abused oil exhibit significant changes in their hematological profiles (Abdallah *et al*., 2020). Inflammatory responses are also unregulated, marked by elevated levels of white blood cells. These inflammatory makers are often associated with various diseases, including cardiovascular diseases, autoimmune disorders and cancer (Barbaro and Harrison, 2019).

Given the health risk posed by thermal oil abuse, there is growing interest in the potential of natural products with therapeutic properties to mitigate these adverse effects. Among these, turmeric (*Curcuma longa*) and pomegranate (*Punica granatum*) have gained attention due to their rich bioactive compounds and proven medicinal properties (Fuloria *et al*., 2022; Ranjha *et al*., 2023). Turmeric is primarily known for its potent antioxidant, anti-inflammatory, and anticancer activities (Cozmin *et al*., 2024). Studies have demonstrated that curcumin can neutralize free radicals, modulate inflammatory pathways and reduce the formation of cancerous cells in various experimental models (Gupta *et al*., 2020). Pomegranate, on the other hand, is rich in polyphenolic compounds, including punicalagins and anthocyanins, which possess strong antioxidant properties and have been shown to modulate inflammatory responses and inhibit oxidative damage in numerous preclinical studies (Cordiano *et al*., 2024).

Despite the substantial evidence supporting the individual benefits of turmeric and pomegranate using their extracts, their single and combined supplements

of the plants, particularly in countering the toxic impacts of thermally abused oils, remain underexplored. The hypothesis underlying this study is that supplementation with turmeric and/or pomegranate may provide protective effect against the weight dysregulation and hematological alteration induced by thermally abused oils.

MATERIALS AND METHODS

Acclimatization of Animals

Animals were acclimatized for a period of two weeks under controlled light/dark (12hrs) cycles and starter feed and water were given *ad libitum.*

Ethical statement

The study protocol was approved by the FUOYE faculty of Science Ethics Committee with approval number FUOYEFSC 201122 –REC2025/028, ensuring that the experiments were designed to minimize animal suffering and distress. Efforts were made to reduce the number of animals used in the experiment while maintaining the scientific integrity and reliability of results.

Plant Sample Collection, Identification and Preparation

The rhizomes of turmeric were purchased from the local market in Dutsin-Ma and were identified by a Botanist from Department of Plant Science and Biotechnology at the Federal University Dutsin-Ma with herbarium number FUDMA/PSB/00011. The rhizomes were thoroughly washed, dried in the shed, and ground into a fine powder, which was then stored for use in diet supplementation. Additionally, pomegranate powder with herbarium number FUDMA/PSB/00379 was purchased from Al-Hilal Islamic Chemist in Katsina.

Preparation of Thermally Abused Oil

Fresh vegetable oil was selected and heated to 180^{o}C using thermostatically controlled deep fryer for 2 hours to stimulate frying conditions. After heating, the oil was allowed to cool to room temperature for 1 hour. The heating (at 180^{o}C for 2 hours) and cooling cycle was repeated six times consecutively to induce thermal degradation. Following the final heating cycle, the oil was cooled to room temperature (Fweja, 2019). The thermally degraded oil was then collected and stored in sterile, clean containers for use in formulating rats' diet.

Feed Composition

Standard rat chow was prepared by carefully mixing corn starch, soya bean meal (SBM), cellulose, salt, vitamin mix, and mineral mix as contained in table 1 (Idoko *et al*., 2022).

Table 1: Detailed components used in feed formulation for a 100 g diet.

Feed ingredients (g)	Control Diet (g)	Reused Oil Diets (g)
Corn Starch	55.45	55.45
SBM	32	32
Cellulose	4.5	4.5
Bone Meal	1.25	1.25
Salt Mix	0.3	0.3
Pre-Mix	0.25	0.25
Methionine	0.25	0.25
Palm oil	60	-
Thermally abused oil	-	60

Supplemented Diet Formulation

The supplemented diets were formulated by mixing 97 g control diet and 3 g of pomegranate and/or turmeric, another supplemented diet was formulated by mixing 97 g thermally abused oil-based diet with 3 g pomegranate and/ or turmeric. Mixed supplementations were made by mixing 1.5 g each of turmeric and pomegranate with 97 g of standard diet or thermally abused oil-based diet.

Experimental Design

Forty (40) female Wister rats, weighing between 60 to 110 g were used in this experiment. The rats were weighed and grouped randomly into eight (8) groups of 5 rats each as follows;

Group 1 was maintained on standard rat diet (control)

Group 2 was maintained on thermally abused oil based diet (positive control)

Group 3 was maintained on 3 % *Curcuma longa* supplemented diet.

Group 4 was maintained on 3 % *Punica granatum* supplemented diet.

Group 5 was maintained on 3 % mixed *Curcuma longa* and *Punica granatum* supplemented diet.

Group 6 was maintained on 3 % *Curcuma longa* and thermally abused oil supplemented diet.

Group 7 was maintained on 3 % *Punica granatum* and thermally abused oil supplemented diet.

Group 8 was maintained on 3 % mixed *Curcuma longa, Punica granatum* and thermally abused oil-baseddiet.

The rats were kept on their respective diets and water *ad libitum* for a period of twelve (12) weeks.

Sacrifice, Sample Collection and Sample Preparation
At the end of twelve weeks, the animals were anesthetized using chloroform, sacrificed by cutting the jugular vein until complete bleeding and the blood samples were collected in EDTA-treated tubes and kept until analysis (Idoko *et al*., 2023).

Determination of Feed Intake and Weight Changes
Feed intake of rats was measured every day with a digital weighing balance from the start date, at the end of the feeding trial, the average feed weight of each group was taken to determine the final feed intake. The weight changes were also taken with digital weighing balance, at the end of the experiment, the % weight gain was calculated by the formulae

$$\%\, weight\ gain = \frac{W2 - W1}{w1} * 100\%$$

Where W1 is the Final average weight, W2 is the initial average weight (Astiti *et al*., 2021).

Determination of Hematological Indices
The hematological indices were determined using an automated hematological analyzer (Beckman Coulter DxH 800 model). Manufacturer's guidelines were followed for the calibration of the analyzer.

Statistical Analysis
Data analysis was performed using the Statistical Package for the Social Sciences (SPSS) version 23. One-way analysis of variance (ANOVA) was conducted, and the Duncan multiple range test was applied to determine where significant differences existed.

RESULTS AND DISCUSSION

Results

Feed Intake
Table 2 shows the results of feed intake of Wistar rats fed thermally abused oil and supplemented with turmeric and/or pomegranate. The result showed a significant ($p<0.05$) increase in feed intake in the group maintained with turmeric and the group fed mixed turmeric and pomegranate supplemented diets while other groups showed no significant ($p>0.05$) change in their feed intake.

Table 2; Feed intake of rats

Group	Feed intake
1	58.23 ± 1.34^{bc}
2	53.20 ± 1.94^{ab}
3	67.82 ± 1.98^{d}
4	59.56 ± 1.64^{c}
5	72.04 ± 1.89^{d}
6	48.46 ± 3.07^{a}
7	47.95 ± 1.97^{a}
8	57.13 ± 1.71^{bc}

Results are SEM ± of twelve determinations. Results with same superscripts are not statistically different ($p>0.05$) while results with different superscript are statistically different ($p<0.05$).

1; group fed normal control diet, 2; group fed thermally abused oil based diet, 3; group fed 3 % *Curcuma longa* supplementeddiet, 4; group fed 3 % *Punica granatum* supplemented diet, 5; group fed 3 % mixed *Curcuma longa* and *Punica granatum* supplemented diet, 6; group fed 3 % *Curcuma longa* + thermally abused oilbaseddiet, 7; group fed 3 % *Punica granatum* + thermally abused oilbaseddiet, 8; group fed 3 % mixed *Curcuma longa* and *Punica granatum* + thermally abused oil based diet.

WEIGHT CHANGES
Table 3 shows the percentage weight gain of Wistar rats fed thermally abused oil and fed turmeric and/or pomegranate supplemented diets. The results showed high percentage increase in weight of rats fed thermally abused oil compared to groups fed control and turmeric and/or pomegranate supplemented diet.

Table 3: Weight changes of rats fed thermally abused oil and supplemented with turmeric and/or pomegranate

Group	Final average weight (g)	Initial average weight (g)	Final – Initial weight (g)	% weight change (%)
1	212	125	86.8	69.3
2	215	108	107	98.9
3	230	129	101	78.8
4	197	128	69.2	54
5	239	128	110	85.9

6	197	118	79.3	67.4
7	227	127	99.8	78.6
8	188	126	62.4	49.6

1; group fed normal control diet, 2; group fed thermally abused oil based diet, 3; group fed 3 % *Curcuma longa* supplementeddiet, 4; group fed 3 % *Punica granatum* supplemented diet, 5; group fed 3 % mixed *Curcuma longa* and *Punica granatum* supplemented diet, 6; group fed 3 % *Curcuma longa* + thermally abused oilbaseddiet, 7; group fed 3 % *Punica granatum* + thermally abused oilbaseddiet, 8; group fed 3 % mixed *Curcuma longa* and *Punica granatum* + thermally abused oil based diet.

HEMATOLOGICAL INDICES

Table 4 showed the results of hematological indices of rats fed thermally abused oil and supplemented with turmeric and/or pomegranate. The results showed significant ($p<0.05$) decrease in all white blood cell parameters but significant ($p<0.05$) increase in PCV in groups treated with turmeric and/or pomegranate compared to the group fed thermally abused oil based diet.

Table 4; Hematological indices

GROUP	WBC	LYMPHOCYTES	MONOCYTES	NEUTROPHILS	EOSINOPHILS	BASOPHILS	PCV	PLATELATES
1	94.40 ± 0.58^{c}	80.87 ± 0.72^{b}	0.23 ± 0.03^{a}	17.13 ± 1.02^{c}	0.63 ± 0.09^{ab}	0.33 ± 0.03^{b}	25.27 ± 0.44^{c}	251.00 ± 1.15^{b}
2	108.0 ± 1.53^{e}	86.33 ± 0.03^{e}	0.87 ± 0.03^{b}	20.43 ± 0.33^{e}	1.03 ± 0.52^{b}	0.73 ± 0.09^{c}	21.17 ± 1.01^{a}	1037.00 ± 32.08^{f}
3	68.00 ± 0.58^{a}	78.17 ± 0.88^{a}	0.13 ± 0.03^{a}	12.67 ± 0.03^{a}	0.17 ± 0.07^{a}	0.30 ± 00^{b}	27.77 ± 0.59^{de}	206.67 ± 2.85^{a}
4	89.37 ± 0.72^{b}	79.20 ± 0.64^{ab}	0.17 ± 0.03^{a}	14.57 ± 0.15^{b}	0.37 ± 0.09^{ab}	0.23 ± 0.03^{a}	28.43 ± 0.33^{e}	208.00 ± 3.51^{a}
5	95.33 ± 2.70^{c}	80.53 ± 0.31^{bc}	0.23 ± 0.03^{a}	17.50 ± 0.06^{c}	0.43 ± 0.09^{ab}	0.53 ± 0.03^{c}	26.73 ± 0.44^{cd}	238.67 ± 0.88^{ab}
6	99.30 ± 0.58^{d}	84.20 ± 0.83^{d}	0.23 ± 0.03^{a}	19.57 ± 0.32^{de}	0.73 ± 0.03^{ab}	0.60 ± 0.06^{c}	25.77 ± 0.30^{c}	430.00 ± 1.76^{d}
7	99.17 ± 0.03^{d}	80.80 ± 0.30^{bc}	0.27 ± 0.03^{a}	19.70 ± 0.35^{de}	0.70 ± 0.15^{ab}	0.63 ± 0.09^{c}	25.77 ± 0.28^{c}	334.00 ± 1.15^{c}
8	95.33 ± 0.84^{c}	82.07 ± 0.78^{c}	0.33 ± 0.15^{a}	18.47 ± 0.32^{cd}	0.87 ± 0.03^{ab}	0.67 ± 0.09^{c}	23.47 ± 0.33^{b}	942.00 ± 1.76^{e}

Results are SEM ± of three determinations. Results with same superscripts are not statistically different ($p>0.05$) while results with different superscript are statistically different ($p<0.05$).

1; group fed normal control diet, 2; group fed thermally abused oil based diet, 3; group fed 3 % *Curcuma longa* supplementeddiet, 4; group fed 3 % *Punica granatum* supplemented diet, 5; group fed 3 % mixed *Curcuma longa* and *Punica granatum* supplemented diet, 6; group fed 3 % *Curcuma longa* + thermally abused oilbaseddiet, 7; group fed 3 % *Punica granatum* + thermally abused oilbaseddiet, 8; group fed 3 % mixed *Curcuma longa* and *Punica granatum* + thermally abused oil based diet.

Discussion

Feed Intake

The result in Table 3 indicated that all groups showed no statistical difference in feed intake, except for group 3 (turmeric-only diet) and group 5 (mixed turmeric and pomegranate diet), which exhibited a significant increase in feed intake. The significant increase in group 3 maybe due to the primary bioactive compound in turmeric, curcumin, which has known antioxidant and anti-inflammatory properties (Guo *et al*., 2020). Curcumin's effect on metabolism and appetite regulation is associated to its ability to modulate appetite-regulating hormones, such as ghrelin (the hunger hormone) and leptin (the satiety hormone) (Al Asoom *et al*., 2023). Curcumin's influence on serotonergic signaling in the brain, particularly in the

hypothalamus, could contribute to its effect on appetite (Labban *et al*., 2022). It can increase serotonin, a neurotransmitter that plays key role in satiety (Planes Muñoz, 2021). This might explain why rats in group fed 3% supplemented diet exhibited a significant increase in feed intake-possibly due to a biochemical alteration in neuroendocrine signaling leading to enhanced hunger or food intake. Curcumin has also been reported to promote thermogenesis, which increase energy expenditure and metabolic activity (Santos *et al*., 2023). This might result in higher food intake, as the rats attempt to compensate for increased energy expenditure. This thermogenic effect could be a biochemical driver behind the observed increase in feed intake, as rats would be consuming more food to meet energy demands caused by the elevated metabolic demands. Curcumin also influences intestinal mobility and gut microbiota, which can affect nutrient absorption and overall digestion (Scazzocchio *et al.*, 2020). The effect of curcumin on gut health could lead to an increase in feed intake as the rats experience improved digestive efficiency and nutrient absorption.

The combination of turmeric and pomegranate in group 5 showed significant increase in feed intake. The combination of curcumin from turmeric and polyphenols (ellagic acid and anthocynins) from pomegranate likely results in synergistic effects that enhance the nutritional absorption, appetite regulation and metabolic efficiency (Saeed *et al*., 2018; Al Asoom *et al*., 2023). Pomegranate has been showed to have antioxidant effects through high content of polyphenols, which can reduce oxidative stress and improve lipid metabolism (Akuru *et al*., 2022). The bioactive compounds in pomegranate help modulate lipid digestion, possibly reducing fatty acid oxidation and promoting more efficient nutrient absorption (Mo *et al*., 2022). This can influence appetite regulation, contributing to an increased feed intake. When combined, curcumin and polyphenols may work together to optimize gut microbiota, improve insulin sensitivity, and reduce inflammation (Jin *et al*., 2018). These combined effects could promote better digestive function, leading to an increase in food intake. The synergistic action of curcumin and pomegranate could also influence the gut-brain axis, enhancing satiety signals and potentially increasing feed consumption to compensate for greater metabolic efficiency (Cerullo *et al*., 2025). Both turmeric and pomegranate have been shown to influence the levels of serotonin and dopamine, key neurotransmitters involved in hunger and mood regulation (Briguglio *et al*., 2018; Gasmi *et al*., 2022). The combination of these two compounds might have a more pronounced effect on brain's appetite-regulating centers, explaining why rats fed the mixed diet had significantly higher feed intake compared to other groups.

Feeding thermally abused oil typically leads to formation of oxidized degradation products, such as aldehydes, ketones, and other free radicals (Machado *et al*., 2023), which can adversely affect gut health and appetite regulation. The detrimental effects of thermally abused oil may cancel out any appetite-enhancing effects from the diet, leading to no significant change in feed intake when compared to the control group. Other groups fed thermally abused oil with supplementation of turmeric and/or pomegranate also showed no significant difference in feed intake compared to the control group. This may be due to the negative impact of thermally abused oil on appetite and metabolic regulation (Oyirifi, 2024). Although turmeric and pomegranate have beneficial effects, the presence of oxidized products from the thermally abused oil likely out weighted the positive effects of the supplements. Thermally abused oil can lead to increased oxidative stress, inflammation, and reduced nutrient absorption, all of which may suppress the appetite-enhancing effects of the supplements.

Weight Changes

The results showed that thermally abused oil fed group (group 2) have the highest percentage weight gain (98%). The thermally abused oils are often rich in oxidized fat and polyunsaturated fatty acids that have been degraded into shorter, more easily absorbed fatty acid products (Sharma *et al*., 2022). These breakdown product can lead to increased caloric intake and efficient absorption in the gastrointestinal tract. As a result, the rats in this group are able to accumulate fat mass rapidly, leading to a high weight gain percentage. Furthermore thermally abused oil can lead to formation of reactive compounds such as lipid peroxides, aldehydes, and ketones (Machado *et al*., 2023). These compounds, while harmful in the long term, might enhance nutrient absorption in the short term by disrupting the gut integrity and increasing the permeability of intestinal lining, allowing more calories from the food to be absorbed (Schaich *et al*., 2020). This could explain the significant weight observed in this group. In another way, oxidative stress induced by thermally abused oil might also trigger an increase in food consumption (Falade *et al*., 2017). Reactive oxygen species have been linked to hunger signals and enhanced feeding behavior in rodents, contributing to increased feed intake and, consequently, increased weight gain (Drougard *et al*., 2015).

The results also showed that mixed turmeric and pomegranate supplemented diet (group 5) with 85.9% weight gain may be due to the synergistic antioxidant effect of turmeric (curcumin) and pomegranate (polyphenols) in group 5 provide potent antioxidant and anti-inflammatory effects (Memarzia *et al*., 2021). These bioactive compounds could improve metabolic function (Alami *et al*., 2023), insulin sensitivity (Banaszak *et al*., 2024), and fat metabolism, leading to

a more efficient use of nutrients and possibly promoting weight gain, although not as much as the thermally abused oil-based diet. Curcumin from turmeric has been shown to influence lipid metabolism by reducing lipogenesis and increasing fat oxidation (Nosrati-Oskouie *et al*., 2021). However, in the context of mixed supplementation with pomegranate, the overall effect could be enhanced by improved digestive health and gut microbiota modulation, which aids in nutrients absorption. The combination of curcumin and pomegranate polyphenols may promote fat storage in adipocytes due to improved caloric absorption, leading to observed weight gain (Boccellino and D'Angelo, 2020), albeit to a lesser extent than thermally abused oil. Both turmeric and pomegranate can influence appetite regulating hormones like ghrelin and leptin (Saad *et al*., 2017). The combination may increase food intake by promoting appetite, but this is still modulated by less potent effects compared to the more calorically dense thermally abused oil group.

The results also indicated that turmeric supplemented diet (group 3) with percentage weight gain of 78.8% lower to group 2 and 5 may be due to the curcumin's thermogenic effects and increased fat oxidation, it may also exert a balancing effect on metabolic rate, potentially preventing excessive fat accumulation (Han *et al*., 2021). In group 3, the rats' weight gain may be moderate due to enhanced energy expenditure and improved metabolic efficiency induced by curcumin. Curcumin's anti-inflammatory properties also contribute to the maintenance of lean body mass, thereby limiting fat storage. Curcumin influences the levels of ghrelin, a hunger hormone that stimulate food intake, and leptin, which signals satiety (Boix-Castejón *et al*., 2023). The modulation of these hormones could explain the moderate weight gain observed in group 3 compared to the high gain in the thermally abused group.

The results also showed that pomegranate supplemented diet (group 4) with 54% weight gain lower than the preceding groups due to polyphenols, especially ellargic acid, have antioxidant and anti-inflammatory properties, which can regulate lipid metabolism and reduce fat accumulation (Xu *et al*., 2021). However compared to turmeric, pomegranate may have a less pronounced effect on energy balance and thermogenesis, explaining the lower weight gain seen this group. Pomegranate may also improve intestinal health and glucose metabolism, which could lead to improved nutrient absorption (Hou *et al*., 2019), but this may not translate into as much weight gain as observed in thermally abused oil or mixed turmeric and pomegranate groups. Pomegranate's effect on appetite regulation may also be less potent, resulting in a more modest increase in weight gain.

The results further showed that turmeric supplemented diet and thermally abused oil-based diet (group 6) have minimal weight gain which shows that thermally abused oil has adverse effect on metabolism due to formation of toxic compounds (Idoko *et al*., 2025). While turmeric might counteract some of the oxidative stress and inflammation caused by thermally abused oil, the negative effects of thermally abused oil on nutrient absorption and metabolism might still outweigh the beneficial effects of turmeric supplementation. Thermally abused oil's negative impact on gut lining and intestinal permeability could reduce the overall caloric absorption despite the presence of turmeric's beneficial effects. Therefore, weight gain in this group was minimal compared to the groups where no thermally abused oil was present.

In the group supplemented with pomegranate supplemented diet with thermally abused oil (group 7) the result showed that the presence of thermally abused oil in group 7 likely had a similar negative effect on weight gain as in group 6, with added inflammatory effect of pomegranate insufficient to overcome the negative impact of the thermally abused oil. The pomegranate polyphenols could improve insulin sensitivity and lipid metabolism, but they could not fully mitigate the oxidative damage caused by the degraded oil. The oxidative damage and inflammatory response induced by thermally abused oil may suppress food intake in group 7, thus reducing the overall weight gain.

Hematological Indices

The result showed a significant increase in all white blood cells but significant decrease in PCV in group maintained on thermally abused oil without any treatment. The significant increase in lymphocytes, monocytes, basophils and platelets may result from production of reactive oxygen species (ROS), leading to oxidative stress (Sillar *et al*., 2019). Harmful lipid peroxides, aldehydes and other ROS are produced when oils are heated (Ahmed *et al*., 2016). These ROS lead to cellular damage, which triggers an inflammatory response (Chelombitko, 2018). The body compensates by increasing the production of immune cells to fight the perceived threat (Tseng *et al*., 2023). This explains the observed increase in these cells. Platelets play significant role in inflammation (Margraf and Zarbock, 2019), and their increase in group 2 may be a response to the oxidative damage and potential need for tissue repair and homeostasis. Platelet production is also stimulated by pro-inflammatory cytokines, which are elevated due to oxidative stress induced by thermally abused oil (But *et al*., 2023). The significant decrease in PCV may be due to hemolysis and decreased RBC production (Ferreira *et al*., 2018). PCV is the measure of percentage of red blood cells in blood (Asaduzzaman *et al*., 2018). Thermally abused oil-induced oxidative stress can lead to hemolysis and decrease in the life span of RBCs. This reduces the

number of circulating red blood cells, which in turn lower PCV. Oxidative damage can also affect bone marrow function, reducing the production of new red blood cells (Pandey and Rizvi, 2011). This would result in lower hematocrit and PCV values, reflecting a decreased oxygen-carrying capacity of the blood. While eosinophil and neutrophils are involved in immune responses, particularly in allergic reactions and bacterial defense (Son *et al*., 2020), they did not show significant changes. This suggest that the oxidative damage and inflammation caused by thermally abused oil did not strongly affect the specific pathways responsible for the production of these two cell types.

The control group maintained higher WBC counts, suggesting a normal immune function in the absence of oxidative stress or any exogenous inflammatory stimuli. This reflects a balanced immune response under physiological conditions. The higher levels of immune cells such as lymphocytes, monocytes, and basophils are indicative of a healthy immune system actively defending against pathogens or minor stressors in the body (Akhand and Ahsan, 2023).

In turmeric-supplemented diet group (group 3) the results show that curcumin, the active compound in turmeric, is well known for its anti-inflammatory and antioxidant properties. Curcumin works by scavenging free radicals and reducing oxidative stress, which would modulate immune function (Memarzia *et al*., 2021). As a result, the increase in WBC, lymphocytes, monocytes, and other immune cells was modest in the group 3 compared to the thermally abused oil group, as the turmeric supplementation likely mitigated oxidative stress and inflammation to some extent. Significant increase in PCV in the group may be due to support of curcumin in hematopoiesis by improving iron bioavailability and protecting the bone marrow from oxidative damage (Hatairaktham *et al*., 2021). This would lead to higher PCV compared to the thermally abused oil group and the control group.

The result in the group fed mixed turmeric and pomegranate supplemented diets suggested that the combined antioxidant and anti-inflammatory of both turmeric and pomegranate likely had a synergistic effect on the immune system, providing stronger protection against oxidative stress and reducing inflammatory response. As a result, the increase in WBC, lymphocytes, monocytes, basophils and platelets was moderate but more pronounced than in groups 3 and 4, reflecting the enhanced immune function due to the combination of both supplements. The combination of curcumin and pomegranate polyphenols could improve red blood cell production through enhanced nutrient absorption and iron utilization (Ma *et* al., 2025), leading to higher PCV than in the thermally abused oil-fed group and the control.

CONCLUSION

In conclusion, the results of this study demonstrated that *Curcuma longa* and *Punica granatum* supplementation offer significant therapeutic benefits mitigating the adverse effects of thermally abused oil on weight regulation and hematological parameters in Wistar rats. The data suggested that thermally abused oil consumption induces weight dysregulation and hematological imbalances. However, turmeric and pomegranate were found to effectively counteract these disturbances, with combined supplementation showing the most profound effect in improving normal weight and hematological function.

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