Journal of Agriculture and Veterinary Science
ISSN: 2959-1198 (Print), 2959-1201 (Online)

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Research Article

Improving Broiler Performance and Carcass Quality with Mint Leaves and Enzyme Additives

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ABSTRACT

The present experiment was conducted at Poultry Experimental Station, Department of Poultry Husbandry, Faculty of Animal Husbandry and Veterinary Sciences, Sindh Agriculture University Tandojam. Three hundred (300) day old Hubbard broilers were equally distributed in 4 groups each having 75 chicks and 3 replicates with15 chicks each. Group A kept as control group - basal diet; Group B fed on basal diet + Mint leaves (1% of total feed composition by weight); Group C fed on basal diet + enzyme (recommended concentration 1.01 gm/kg of feed); Group D fed on basal diet + mint leaves + enzyme (combination of 1% mint leaves and 1.01 gm/kg of the enzyme). The trial was ended up to 42 days. The growth performance and carcass characteristics of broiler were determined. Results showed that fed intake was non-significant (P>0.05) between the A, B and C groups, while significant (P<0.05) among group D and A, B, C groups. Slightly higher feed intake (3785.0g/b) was noted in D group followed by C group (3771.0g/b), B group (3765.0g/b) and A group (3723.7g/b), respectively. Significantly (P<0.05) maximum live body weight (2306.7g/b) was noted in D group followed by C group (2217.7g/b), B group (2198.7g/b) and A group (2092.3g/b), respectively. Significantly (P<0.05) carcass weight was noted high in D group (1606.7g/b) followed by C group (1517.7g/b), B group (1498.7g/b) and A group (1492.3g/b), respectively. Significantly (P<0.05) dressing was noted high in A group (71.32%) followed by D group (69.65%), C group (68.43%) and B group (68.16%), respectively. Better FCR (1.64) was noted in D group followed by C group (1.70), B group (1.71) and A group (1.77), respectively. FCR was non-significant (P>0.05) between the A, B and C groups, while significant (P<0.05) among group D and A, B, C groups. Maximum Water Holding Capacity (56.71%) was noted in D group followed by C group (51.74%), B group (47.13%) and A group (41.64%), respectively. Maximum cooking loss (20.32%) was noted in A group followed by B group (17.99%), C group (17.63%) and D group (17.60%), respectively. Maximum drip loss (23.62%) was noted in A group followed by B group (19.55%), C group (19.40%) and D group (18.63%), respectively. Maximum fat content (4.36%) was noted in D group followed by C group (3.72%), B group (3.32%) and A group (2.19%), respectively. Maximum glycogen content (1.32%) was noted in D group followed by C group (1.05%), B group (0.88%) and A group (0.45%), respectively. In conclusion, the supplementation of mint leaves and enzymes (Group D) significantly improved various performance parameters and carcass characteristics of broilers, including feed intake, live body weight, carcass weight, FCR, WHC, and reduced cooking and drip losses. The combination of mint leaves and enzymes in the diet of broilers proves to be beneficial for enhancing overall growth performance and meat quality.

Keywords: Broiler, Carcass, Enzyme, Meat, Mint.

OPEN ACCESS

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Article History
Received: July 20, 2024
Accepted: August 28, 2024
Published: August 30, 2024

INTRODUCTION

Growth-promoting antibiotics (GPAs) are commonly employed to boost the productivity of livestock raised for meat. However, the extensive use of these antibiotics in animal husbandry can contribute to the rise of antibiotic-resistant bacteria, leave residues of antibiotics in animal products, and potentially transfer resistant strains to humans through the food chain (Stanacev et al., 2011). To combat these issues, the European Union implemented regulations in 2006 to reduce or ban the use of GPAs in meat and egg production (Windisch et al., 2008). This ban has led to increased production costs and subsequently reduced profits. In response to the limited or banned use of antibiotic growth promoters, comprehensive research is needed to find effective alternatives that can enhance production efficiency, ensure animal health, and avoid harmful residues in food. One promising alternative is the use of phytogenic additives in poultry production (Castanon, 2007).

The detrimental impact of chemical goods, particularly antibiotics, has prompted the use of natural alternatives such as phytogenic substances to enhance the efficacy of feed utilisation and promote the growth performance of chickens. Phytogenic feed additives are becoming more important because of their antibacterial properties and ability to stimulate the digestive system. These substances consist of herbs, spices, or plants that are used to maintain the natural intestinal microflora of chickens. This is essential for achieving cost-effective and environmentally friendly poultry production (Windisch et al., 2008). When compared to synthetic antibiotics or inorganic compounds, these plants and their derived products have been shown to be less toxic and free of residues. As a result, they are regarded to be excellent feed additions in animal production. According to Hashemi and Davoodi (2010), these herbal plants have immune stimulatory qualities that likely contribute to their good impacts on animal development and health.

Mint, scientifically named Mentha piperita and commonly known as Pudina in local languages, is a member of the Labiatae family. It is widely used in herbal medicine and is believed to have immunomodulatory effects (Nanekarani et al., 2012). Mint is frequently consumed after meals because it can help relieve indigestion and intestinal spasms by reducing gastrocolic reflex (Spirling and Daniels, 2001). The leaves and flowers of mint contain a high concentration of menthol, the main phenolic compound responsible for its antibacterial properties (Schuhmacher et al., 2003). Additionally, mint is rich in polyphenolic compounds, which indicate its potential as a powerful antioxidant (Dorman et al., 2009). Besides its health benefits, mint can repel rodents and pests and has a calming effect on laying hens. Mint enhances the breakdown of non-starchy polysaccharides and improves their digestion, resulting in a positive impact on the structure of the gut and ultimately enhancing the absorption of nutrients. It is often used in herbal therapy and is believed to be quite beneficial in enhancing immunity and combating secondary infections. The study done by Hussein et al. (2021) shown that peppermint exhibits significant protective effectiveness in mitigating the decline in performance and intestinal health of broiler chickens afflicted with coccidiosis. Peppermint leaves have a stimulatory effect on the development of broilers throughout their early stages of life (Toghyani et al., 2010) and enhance the quality of eggs (Abdel-Wareth and Lohakare, 2014). Additionally, (Khempaka et al., 2013) documented that peppermint leaves have advantageous properties in terms of antioxidant activity, belly fat accumulation, and ammonia generation in grill chickens. Furthermore, there is a scarcity of information about the impact of peppermint leaves and menthol on the growth performance and meat quality of chickens.

The use of commercial enzymes in poultry feeding is very significant. The main obstacle in almost all emerging nations has been a proportional rise in the cost of feed components. Therefore, it is advisable to use cost-effective alternative feed components that have a larger proportion of non-starch polysaccharides (NSPs) in addition to starch. Non-starch polysaccharides are complex carbohydrates that differ from starch in their structure and content (AJ, 1995). As a result, birds are unable to fully digest them (Adams and Pugh, 1993). Some non-starch polysaccharides (NSPs) are soluble in water, which hinders the formation of a gel-like, thick texture in the intestinal tract (Ward, 1995). As a result, the performance of the gut is reduced. β-glucans generally have an adverse impact on nutrient absorption, particularly when it comes to the utilisation of carbohydrate and protein. This is especially true in the very fluid environment of the small intestine in chicks (Hesselman and Åman, 1986). Poultry lacks the enzymes necessary to break down non-starch polysaccharides (NSPs) found in grain cell walls. As a result, these NSPs remain undecomposed and may lead to a decrease in feed efficiency (Choct et al., 1995). Adding beneficial external enzymes to the diets is seen as a way to counteract the negative effects of non-starch polysaccharides (NSPs). Enzymes degrade the non-starch polysaccharides (NSPs), decrease the thickness of the intestines, and thus enhance the ability to digest nutrients by enhancing the functioning of the gastrointestinal tract (Amerah, 2015). Enzymes induce the breakdown of the structural integrity of the plant cell wall, leading to the subsequent release of

nutrients that are enclosed inside the cell wall (Ravindran, 2013).

Xylanase:

Xylanse enzyme use in feed to reaks insoluble fiber into smaller particles resulting in increased lower gut fermentation, Reduces guts viscosity and wet litter and Releases some energy and a small amount of protein.

Amylase:

Its actions complement the secretion of endogenous amylase by the bird, freeing up energy to fuel growth. Increasing starch digestibility also reduces the presence of glucose as a potential substrate for non-beneficial bacteria in the latter part of the GIT.

Phytase:

Phosphorous is a key nutritional requirement for poultry to provide bone growth. Most of the phosphorus contained in animal feed of plant origin exists in the storage form phytate. Poultry cannot digest phosphorus contained within phytate, since they lack phytase enzyme that breaks down this phytate molecule. Therefore the inclusion of the phytase enzyme in poultry feed is required for release of phytate bound phosphorus.

Protease:

Protease in poultry feed can improve digestibility and reduce nutritional gaps. Due to improved protein digestibility, protease enzyme reduces hind gut fermentation by reducing undigested protein entering in the large intestine and therefore, improving guts health.

This research aimed to assess the effectiveness of feed additives, namely peppermint leaves and its main active component, menthol, combined with enzymes, in enhancing the growth Performance and meat quality of grill chickens.

MATERIALS AND METHODS

Study Area

The present experiment was conducted at Poultry Experimental Station, Department of Poultry Husbandry, Faculty of Animal Husbandry and Veterinary Sciences, Sindh Agriculture University Tandojam.

Diet and additives

The locally available Mint leaves (Mentha piperita) were purchased from the commercial market at Hyderabad, Sindh, Pakistan. The material was dried on sunlight and stored properly for future use. Dried samples of herb were subjected to proximate analysis as per standard procedures. The enzymes were purchased from poultry feed market. In addition, the commercial feed was purchased from AgriCrop H.S feed company (Hyderabad, Sindh Pakistan).

Diet plan and bird distribution

Three hundred (300) day old Hubbard broilers were equally distributed in 4 groups each having 75 chicks and 3 replicates with15 chicks each. Group A kept as control group - Basal diet; Group B fed on basal diet + Mint leaves (1% of total feed composition by weight); Group C fed on basal diet + enzyme (recommended concentration (1.01gm/kg of feed); Group D fed on basal diet + mint leaves + enzyme (combination of 1% mint leaves and recommended concentration of the enzyme). All the diets were prepared with the same batch of ingredients with same composition. Identical standard management practices regarding feeding, watering and disease control etc. were followed for each group during entire experiment of study.

Table 1. Experimental Design for the treatment groups and additives

Treatment	Groups	Dosage (Additives)
T1	Control group - Basal diet	No additives
T2	Basal diet + Mint leaves	1% of mint powder total feed composition by weight
T3	Basal diet + Enzyme	Recommended concentration (1.01 gm/kg) in feed
T4	Basal diet + Mint leaves + Enzyme	Combination of 1% mint leaves and recommended concentration (1.01gm/kg) of the enzyme in feed

Table 2. Proximate composition of mint leaves powder

Mint powder 100g	Moisture	Fat	Protein	Carbohydrate	Crude fiber	Ash
	4.81 %	2.90 %	13.22 %	52.00 %	17.65 %	10.00 %

Table 1a. Boost feed with mint and enzymes.

Mint Powder	10gm/kg of feed
Amylase	0.005gm/kg of feed
Xylanase	0.5gm/kg of feed
Protease	0.005gm/kg of feed
Phytase	0.5gm/kg of feed
Total Enzyme	1.01gm/kg of feed

Growth performance

Feed and water were given twice daily (morning & evening) and refusal was weighed and recorded next day. Live body weight was recorded from each group randomly selected three birds, weighted (using electric weighing scales. Two birds from each group were randomly selected and slaughter on 42 days for carcass weight and dressing %.

$$\text{Dressing \%} = \frac{\text{Weight of carcass (\#) X 100}}{\text{Weight of live bird (\#)}}$$

FCR was calculated by the following formula:

$$\text{FCR} = \frac{\text{Total feed intake}}{\text{Total live body}}$$

Carcass characteristic

The pH values of chicken meat samples were examined as described by Toghyani et al. (2010), pH model (Ezdo Taiwan), used in this experiment. Water holding capacity (WHC) of meat samples were determined according to the method developed by (Ward, 1995). Centrifuge machine (Model Tj-6 Beckman, USA, used to examine the water holding capacity and glycogen content. Drip loss of meat sample were determined by the method as described by Aaslyng et al. (2003), Refrigerator (Model 9188 wbm, Pakista) used to preserve samples and analysis of drip loss .Moisture content of meat samples were calculated by the process as reported by Association of Official Analytical Chemists (AOAC, 2000). Protein of meat samples were determined by the Micro Kjeldhal method as described in book of AOAC, (2000) Kjeldhal digestion unit (Model LABCONCO Mod 60300-01) .Total fat content of meat samples were extracted in Soxhlet Extraction Unit (model Lablin Melrose park, ILL) as described by AOAC (2000). Glycogen content of meat samples were calculated by the method as described by Mendel et al. (1954), Spectrophotometer (Model U-1800 UV-VUS Tokyo Japan), was used to calculate glycogen level of meat sample.

Statistical analysis

The data were tabulated in excel and analyzed by one way ANOVA using SPSS 19. The means and means of standard errors were expressed. For significance of result the Turkey test was applied. The P value is set at ≤ 0.05.

RESULTS

Growth performance of broiler

Feed intake (g/b)

Results regarding effect of peppermint and enzyme supplementation on feed intake of broiler are shown in table 3. Data indicates that slightly higher feed intake (3785.0g/b) was noted in D group followed by C group (3771.0g/b), B group (3765.0g/b) and A group (3723.7g/b), respectively. Feed intake was non-significant ($P>0.05$) among the A, B and C groups, while group D was significant ($P<0.05$) among the other groups.

Water intake (ml/b)

Results regarding effect of peppermint and enzyme supplementation on water intake of broiler is shown in table 3.Data indicates that slightly higher water intake (7570.0ml/b) was noted in group D followed by C group (7542.0ml/b), B group (7530.0ml/b) and A group (7447.3ml/b), respectively. Water intake was non-significant ($P>0.05$) between the A, B and C groups, while group D was significant ($P<0.05$) among the other groups.

Live body weight (g/b)

Results regarding effect of peppermint and enzyme supplementation on live body weight of broiler is shown in table 3.Data indicates that higher live body weight (2306.7g/b) was noted in D group followed by C group (2217.7g/b), B group (2198.7g/b) and A group (2092.3g/b), respectively. Live body weight was significant ($P<0.05$) in group D, among the other groups.

Carcass weight (g/b)

Results regarding effect of peppermint and enzyme supplementation on carcass weight of broiler are shown in table 3. Data indicates that higher carcass weight (1606.7g/b) was noted in D group followed by C group (1517.7g/b), B group (1498.7g/b) and A group (1492.3g/b), respectively. Carcass weight was significant (P<0.05) in group D, among the other groups.

Dressing (%)

Results regarding effect of peppermint and enzyme supplementation on dressing % of broiler are shown in table 3. Data indicates that higher dressing (71.32%) was noted in group A followed by D group (69.65%), C group (68.43%) and B group (68.16%), respectively. Dressing % was significant (P<0.05) in group A, among other groups.

Feed Conversion Ratio

Results regarding effect of peppermint and enzyme supplementation on FCR of broiler are shown in table 3. Data indicates that better FCR (1.64) was noted in D group followed by C group (1.70), B group (1.71) and A group (1.77), respectively. FCR was non-significant (P>0.05) between the A, B and C groups, while significant (P<0.05) in group D, among group the other groups.

Table 3. Effect of peppermint and enzyme supplementation on growth performance of broiler.

Group	Feed intake (g/b)	Water intake (ml/b)	Live body weight (g/b)	Carcass weight (g/b)	Dressing (%)	FCR
A	3723.7b	7447.3b	2092.3c	1492.3c	71.32c	1.77a
B	3765.0a	7530.0a	2198.7bc	1498.7bc	68.16bc	1.71a
C	3771.0a	7542.0a	2217.7b	1517.7b	68.43b	1.70a
D	3785.0a	7570.0a	2306.7a	1606.7a	69.65a	1.64b
SEM	17.095	34.189	10.435	10.435	0.1485	0.0216
LSD @ 0.05	39.420	78.840	24.063	24.063	0.3425	0.0498
P-value	0.0345	0.0345	0.0011	0.0047	0.0017	0.0011

Carcass characteristics of broiler

P.H value

Results regarding effect of peppermint and enzyme supplementation on pH value of broiler meat are shown in table 4. Data indicates that pH value was determined as (5.74, 5.53, 5.44, 5.60) in A, B, C and D group, respectively. pH was non-significant (P>0.05) between the A, B, C and D group.

Water Holding Capacity (%)

Results regarding effect of peppermint and enzyme supplementation on WHC of broiler meat are shown in table 4. Data indicates that maximum WHC (56.71%) was noted in D group followed by C group (51.74%), B group (47.13%) and A group (41.64%), respectively. WHC was significant (P<0.05) in group D, among the other groups.

Cooking loss (%)

Results regarding effect of peppermint and enzyme supplementation on cooking loss of broiler meat are shown in table 4. Data indicates that maximum cooking loss (20.32%) was noted in A group followed by B group (17.99%), C group (17.63%) and D group (17.60%), respectively. Cooking loss was non-significant (P>0.05) among the B, C and D groups, while significant (P<0.05) in group A.

Drip loss (%)

Results regarding effect of peppermint and enzyme supplementation on drip loss of broiler meat are shown in table 4. Data indicates that maximum drip loss (23.62%) was noted in A group followed by B group (19.55%), C group (19.40%) and D group (18.63%), respectively. Drip loss was non-significant (P>0.05) between the B, C and D groups, while Group A is significant (P<0.05) from other groups.

Fat content (%)

Results regarding effect of peppermint and enzyme supplementation on fat content of broiler meat are shown in table 4. Data indicates that maximum fat content (4.36%) was noted in D group followed by C group (3.72%), B group (3.32%) and A group (2.19%), respectively. Fat content was significant (P<0.05) in group D, among the others groups.

Glycogen content (%)

Results regarding effect of peppermint and enzyme supplementation on glycogen content of broiler meat are shown in table 4. Data indicates that maximum glycogen content (1.32%) was noted in D group followed by C group

(1.05%), B group (0.88%) and A group (0.45%), respectively. Glycogen content was non-significant (P>0.05) in the A, B and C groups, while significant (P<0.05) in group D, among the others groups.

Ash content (%)

Results regarding effect of peppermint and enzyme supplementation on ash content of broiler meat are shown in table 4. Data indicates that ash content was determined as (1.80, 1.45, 1.14, 1.06%) in A, B, C and D groups, respectively. Ash content was non-significant (P>0.05) among the A, B, C and D groups.

Table 4. Effect of peppermint and enzyme supplementation on carcass characteristicsof broiler.

Group	pH value	WHC (%)	Cooking loss (%)	Drip loss (%)	Fat content (%)	Glycogen content	Ash content (%)
A	5.74	41.64^{d}	20.32^{a}	23.62^{a}	2.19^{c}	0.45^{b}	1.80^{a}
B	5.53	47.13^{c}	17.99^{b}	19.55^{b}	3.32^{b}	0.88^{b}	1.45^{a}
C	5.44	51.74^{b}	17.63^{b}	19.40^{b}	3.72^{b}	1.05^{b}	1.14^{a}
D	5.60	56.71^{a}	17.60^{b}	18.63^{b}	4.36^{a}	1.32^{a}	1.06^{a}
SEM	0.0827	1.3062	0.5446	0.4565	0.0932	0.0610	0.0486
LSD @ 0.05	0.1908	3.0121	1.2559	1.0528	0.2149	0.1406	0.1122
P-value	0.0756	0.0034	0.0029	0.0040	0.0017	0.0384	0.0911

DISCUSSION

The significant increase in feed consumption observed in group D can likely be attributed to the combined effects of the two supplements. Peppermint may enhance the sensory appeal of the feed, while enzymes facilitate nutrient digestion and absorption. This synergy creates a more favorable feeding environment, promoting greater intake and potentially leading to improved growth performance, as evidenced by the higher feed consumption in group Youssef (2011) found that peppermint could enhance the palatability of feed and stimulate the production of digestive fluids, thereby increasing chickens' appetite. Additionally, enzyme supplements play a vital role in improving nutrient digestion and optimizing feed efficiency. Bedford (2000) noted that enzymes help break down components that impede nutrient absorption, resulting in better nutrient availability and enhanced growth performance in broiler chickens. This is consistent with the findings of Patel (2018) and Zeng (2015), who reported that the benefits of enzyme supplementation are amplified when combined with other feed additives that boost overall digestive efficiency. Cowieson and Bedford (2009) also demonstrated that enzyme supplementation is more effective when used alongside additives that promote gut health and nutrient absorption.

The significant rise in live body weight observed in group D can be linked to the combined effects of peppermint and enzyme supplementation, which create a favorable digestive environment, enhancing nutrient absorption and growth. Studies by Hernández (2004) and Kumar (2019) suggest that using multiple feed additives can significantly improve broiler chickens' growth performance. Peppermint enhances feed palatability and stimulates digestive enzyme production, leading to better nutrient absorption (Cross et al., 2007; Youssef, 2011). Additionally, peppermint contains bioactive compounds that support gastrointestinal health and feed utilization efficiency (Windisch et al., 2008). Enzyme supplements are known to break down anti-nutritional factors and enhance feed component digestibility, resulting in improved nutrient utilization and growth (Bedford, 2000; Cowieson and Bedford, 2009). Enzymes such as phytase and carbohydrases help decompose feed materials, making vital nutrients more accessible (Ravindran, 2013).

The improvement in feed conversion ratio (FCR) seen in group D can also be attributed to the synergistic effects of peppermint and enzyme supplementation. A more optimal digestive environment and enhanced nutrient absorption contributed to the efficient conversion of feed into body weight. Research supports that combining feed additives improves FCR in broiler chickens (Hernández, 2004; Kumar, 2019). Peppermint improves feed palatability and stimulates digestive processes, enhancing nutrient utilization and conversion efficiency, leading to better FCR (Windisch et al., 2008; Youssef, 2011). Enzyme supplementation optimizes FCR by enhancing nutrient digestion and absorption (Bedford, 2000; Cowieson and Bedford, 2009). Other studies corroborate the positive effects of peppermint and enzyme supplements on digestive health and nutrient absorption in chickens (Hashemipour et al., 2013; Jamroz et al., 2006).

Differences in water holding capacity (WHC) among groups indicate that both peppermint and enzyme supplementation affect meat's ability to retain moisture. Peppermint supplementation has been linked to improved meat quality traits such as increased WHC by enhancing muscle proteins' water-binding capacity (Placha et al.,

2019). Enzyme supplements also improve WHC by enhancing muscle fiber structure and reducing drip loss (Adeyemi et al., 2019). Our study showed reduced cooking loss in supplemented groups compared to the control, aligning with previous findings that natural additives like peppermint and enzymes can impact meat quality parameters (Lee et al., 2018; Xiong et al., 2017).

The supplemented groups exhibited decreased drip loss compared to the control group, supporting studies showing that different supplements improve WHC and reduce drip loss in meat products (Aaslyng et al., 2003; Cai et al., 2018; Tornberg, 2005). This suggests that peppermint and enzyme supplementation can enhance water retention in meat (Dransfield and Sosnicki, 1999; OFFER, 1988; Sindelar and Milkowski, 2012).

Fat content, crucial for meat quality, was highest in group D, indicating greater lipid accumulation due to dietary interventions with specific compounds or enzymes (Chen et al., 2014; Jayasena et al., 2014). Research indicates that dietary additives influence lipid metabolism and fat accumulation in chickens (Zhou et al., 2020). Peppermint and enzymes affect pathways involved in fat metabolism, altering meat fat content.

Glycogen, essential for muscle energy storage, influences meat quality traits such as flavor and moisture. Group D had the highest glycogen content, suggesting enhanced energy metabolism or nutrient utilization due to its supplementation regimen. This highlights the combined effects of specific supplements on regulating energy metabolism in broiler chickens (Hansen et al., 2009; Koutsos et al., 2007; Rostagno et al., 2011).

CONCLUSION

The addition of mint leaves and enzymes (Group D) significantly enhanced the performance and carcass qualities of broiler chickens. This included improvements in feed intake, live body weight, carcass weight, feed conversion ratio (FCR), and water holding capacity (WHC), along with reductions in cooking and drip losses. Incorporating mint leaves and enzymes into the broilers' feed proved beneficial for both growth performance and meat quality.

AUTHOR CONTRIBUTIONS

Rani Abro; Concept, supervision, study design, research Mariam Minhas; Experimental work and writing initial draft, Shahid Hussain Abro; Validation, manuscript editing and correction, analysis, review writing, Shoaib Ahmed Pirzado; Experimental work and editing, Hakimzadi Wagan; writing, statistical analyses, Farman Ali Siyal; research work, formal analyses Gulfam Ali Mughal, concept, resources and review.

COMPETING OF INTEREST

The authors declare no competing interests.

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