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Impact of Dietary Supplementation of *Carica papaya* Essential Oil on the Blood Chemistry of Broiler Chickens

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Abstract: This study was designed to investigate how adding *Carica papaya* essential oil to the feed affects the blood chemistry of broiler chickens. An 8-week trial, involving 400 one-day-old mixed-sex Ross 307 chicks, was designed. The chicks were divided into 4 groups, each of which contained 100 birds, and 5 replicates, each containing 20 birds. Treatments T1, T2, T3, and T4 received a basal diet with 100 mg, 200 mg, and 300 mg/kg, respectively, of *Carica papaya* essential oil in place of T1's basal diet. Ad libitum feed and clean water were fed to chicks. The results demonstrated that the therapies had no discernible (P>0.05) effect on white blood cells, hemoglobin, red blood cells, or packed cell volume, lymphocytes, monocytes, eosinophils, and neutrophils values in the start and end phases. *Carica papaya* essential oil had no discernible effect (P>0.05) on the levels of total protein, albumin, globulin, creatinine, aspartate transaminase, or alanine phosphatase, except cholesterol levels, which were greater (P<0.05) in T1 than in other treatments in both the start and end phases. All findings, however, fall within the ideal ranges for healthy birds, indicating no signs of infection, inflammation, or metabolic disease. It is concluded that *Carica papaya* essential oil has several bioactive components with therapeutic value and can be used up to 300 mg/kg per kilogram of birds without having any negative effects on the birds' blood profiles.
Keywords: Carica papaya, essential oil, hematology, serum, broilers, food safety.

1. Introduction

There is increasing legislative pressure, according to Kritas and Morrison (2004), to phase out the routine use of relatively tiny doses of antibiotics in animal feed. The European Union already prohibited the use of antibiotic growth promoters as of January 2006 due to concerns regarding the possible spread of antibiotic resistance to human illnesses, drug residues in food-grade animal products, and the environment (Peter, 2021; Adewale et al., 2021). Alternatives like essential oils have been the subject of research instead. According to the World Health Organization (WHO), one of the top three risks to human health in 2009 was antibiotic resistance (Peter, 2021; Singh et al., 2021).
Using essential oils, especially those from Carica papaya, is one option for antibiotic alternatives. According to Burla et al. (2018) and Aruoma et al. (2006), the papaya (*Carica papaya* Linn) is a dicotyledonous, flowering plant that is a member of the Caricaceae family. Tropical America is the plant's original habitat, but it has since expanded to other parts of the world (Juarez-Rojop et al., 2012; Raffaelli et al., 2015). The secondary metabolites found in papaya oils are many and have a variety of functions, including antibacterial, antioxidant, anti-inflammatory, anti-protozoal, and immune-modulatory (Agubosi et al., 2022; Singh et al., 2022; Owoyele et al., 2008). Additionally, it contains a lot of oleic acid and triacylglycerols, which are beneficial for animal health (Aravind et al., 2013; Saliasi et al., 2018). The leaves, roots, stem bark, seeds, and other parts of the plant have

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been utilized in the past to treat a range of illnesses, including malaria, typhoid, gastrointestinal issues, and sexually transmitted diseases (Garcia-Solis et al., 2009; Mikhal' chik et al., 2004).
It is well known that the content and amounts of active chemicals in essential oils from the *Carica papaya* plant vary greatly from region to region, and soil type to climate, among other factors (Oluwafemi et al., 2022; Pungasari et al., 2005). According to in vitro research (Nayak et al., 2012), papaya essential oils can also suppress the growth of Gram +ve and Gram -ve bacteria. According to Somanah et al. (2016), papaya seeds include arginine, histidine, isoleucine, leucine, threonine, proline, and valine among other amino acids.
Previous studies demonstrated that essential oils have a wide range of possible advantages, all of which aim to improve livestock performance (Alagbe, 2022). However, nothing is known about how papaya seed essentially affects the blood profile of birds. Since there is a clear correlation between diet and animal health, an examination of the oil's effectiveness will aid in promoting food safety and determining the appropriate level of inclusion without endangering the bird's health.
Therefore, this study was designed to investigate how adding *Carica papaya* to the diet affected the blood chemistry of broiler chickens.

1. Materials and Methods

1.1 Experimental location, ethical consent, and extraction of *Carica papaya* essential oil

The study was conducted at the Sumitra Institute's Livestock Unit. The research was conducted by the guidelines and requirements of procedures that had been authorized by the Research Ethics Council of Gujarat, India's Sumitra Research Institute.
A competent taxonomist from the Faculty of Biological Sciences obtained fresh *Carica papaya* seeds from the Sumitra Teaching and Research farm for thorough identification and authenticity. Collected seeds were air-dried on the flat metallic tray for 18 days to retain the active components in the seeds and pulverized into size to reduce their surface area. Steam distillation technique was employed in the extraction of *Carica papaya* essential oil. The procedure requires an H-shaped Clevenger apparatus, heating mantle, Graham condenser, safety tube, separatory funnel, round bottle flask, and beaker. 200 grams of pulverized papaya seeds were soaked in the round bottom flask (RBF) with 500 mL water with a heating mantle, and a delivery tube was connected above the RBF with Graham's condenser. The sample was heated to 60 °C and maintained at boiling point, water vapor produced passes through the condenser to the separatory funnel where a layer of water and oil is formed. The tube was gradually released, and the essential oil was collected in a beaker.

1.2 Experimental bird's management, diet, and design

For the experiment, 400 mixed-sex Ross 307 broiler chicks at one day old were purchased from a hatchery in India and split up into four groups, (5 repetitions, each with 20 birds), using a random design. Chicks were kept in semi-closed pens in a battery cage that measured (150cm 90cm 80cm) (length breath height) and was 110cm above the ground. It was furnished with aluminum feeders and nipple drinkers. Glucomol® (glucose + paracetamol) (20 grams per 10 liters of water) and water-soluble vitamin (Vitamix®) at 5 grams per 10 liters of water were provided to the birds as soon as they arrived.

2. Experimental set-up

These were the experimental groups:
An essential oil-free standard feed control group: Group 1
Supplemental group for *Carica papaya* oil: 100 milligrams, 200 milligrams, and 300 mg per kilogram of basic feed in groups 2, 3, and 4, respectively.

1.3 Bioactive compounds of *Carica papaya* essential oil

Using an Agilent 7000B triple quadrupole GC/MS instrument, the bioactive components in *Carica papaya* essential oil were analyzed. It has the following technical specifications: mode (standard), EI (high sensitivity extraction source), mass range (10 to 1.050 m/z), dynamic range (106), scanning speed (up to 6,250 u/s), mass axis stability, electric current (100 to 300 eV), filament (EI double filament), ion temperature (106 to 350 °C) and uncoated proprietary inert collision energy source (60 eV').), detector (triaxial HED-EM with lifetime EM and dynamic scaling aperture), collision cell (linear six-pole), collision cell fuel (nitrogen and helium quenching gases to reduce metastable helium), mass gap (10 to 1,050 m/z), dynamic range (106), scan rate (up to 6,250 u/s), mass axis stability, electron energy (100 to 300 eV), filament (EI double filament), ion temperature (106 to 350 °C), uncoated specific inert collision energy (selectable up to 60eV), detector (triaxial HED-EM with lifetime

EM and dynamic zoom aperture), collision cell (linear six-pole), collision cell gas (nitrogen and helium quenching gas is used to reduce metastable helium),

1.4 Blood collection

Blood was drawn from six randomly chosen birds per replication on the 28th and 56th days of the trial for hematological and serum biochemical analysis. While serum indices were taken into sample bottles without an anticoagulant, blood for hematology was taken into bottles containing an anticoagulant (ethylene diamine tetra acetic acid). White blood cell, pack cell volume, hemoglobin, and red blood cell parameters were extracted using the electrical resistance approach.
Serum biochemical analyses were carried out using a Pictus 700 automatic analyzer (model F1209-06A, Hungary) with the following technical specifications; photometric module, measuring module (25 µL flow cell volume), 15 mm square cuvette, Minimum aspiration volume: 200 µL and analysis mode.

1.5 Chemical analysis of diet

Perkin Elmer's near-infrared (Model DA 7250, England), which examines samples in 60 seconds, was used to analyze the trial diet. The operating temperature range (6 °C to 41°C), wavelength range (900–1700 rpm), and wavelength accuracy (0.05 nm) are the equipment's technical details.

4. Statistical analysis

The General Linear Model technique of Application of Methodology to the Social Sciences (23rd Edition) to do a one-way analysis of variance on statistical data gathered on blood profile. Significant variations were observed at ($P< 0.05$).

Table 1: Ingredient and gross composition of the trial diet (% DM)

Ingredients	Starting diet (0- 28d)	Growing diet (29 – 56 d)
Yellow maize	51.00	55.00
W/O	2.00	5.00
SBM	32.00	30.00
F/M (72 %: imported)	2.00	2.00
GNM	8.00	3.00
Oyster shell	1.50	2.40
Bone meal	3.00	5.00
Lysine	0.20	0.20
Methionine	0.25	0.20
*Premix	0.25	0.25
Salt	0.30	0.40
Toxin binder	0.05	0.05
Total	100.00	100.00
Calculated analysis		
C.P	23.11	19.73
C.F	4.23	5.13
E.E	4.55	4.75
Ca	1.58	1.87
P	0.61	0.91
Lysine	1.52	1.67
Methionine plus cysteine	0.93	0.95
Metabolizable energy (Kcal/kg)	3002.7	3168.6
Laboratory analysis (%)		
C.P	23.48	21.90
C.F	4.00	4.40
E.E	4.60	4.51
Ca	1.66	1.81
P	0.79	0.81
Lysine	1.98	1.98
Meth plus cysteine	1.13	1.32

Metabolizable energy (Kcal/kg)	2996.7	3100.3

W/O: wheat offal; SBM: soya bean meal; GNM: groundnut mealC.P: ham protein; C.F: ham life; Ca: calcium; P: phosphorus.

4.1 Major bioactive compounds of *Carica papaya* essential oil using gas chromatography and mass spectrometry.

Table 2 represents the major bioactive compounds of *Carica papaya* essential oil including their retention time and peak areas. The most abundant compounds include limonene (11.26 %), α-pinene (10.71 %), α-terpineol (8.05 %), myrcene (5.66 %), linalool (4.32 %), α-terpinol acetate (3.06 %), carvone (2.75 %) and γ-terpene (2.07 %). While geranyl acetate, benzyl acetate, 2-methyl propyl acetate, oxacyclohexadec-2-one, cis-methyl dihydro jasmonate, n-hexyl salicylate, and geraniol values are: 1.41 %, 1.22 %, 0.96 %, 0.86 %, 1.33 %, 0.96 %, and 1.04 %, respectively. Limonene, α-pinene, α-terpineol, myrcene, linalool, α-terpinyl acetate, carvone, and γ-terpene are groups of terpenoids with a variety range of pharmacological benefits such as anti-inflammatory, anti-fungal, anti-bacterial, antioxidants, muscle relaxants, sedative, and immune-modulatory roles (Ghosh et al., 2018; Mohammed et al., 2010). They are also responsible for the scent and flavor profiles of *Carica papaya* essential oil and provide therapeutic benefits to the animal's body (Huang et al., 2010). Geranyl acetate, benzyl acetate, 2-methyl propyl acetate, oxacyclohexadec-2-one, cis-methyl dihydro jasmonate, n-hexyl salicylate, geraniol, and veloutone are groups of esters. They are known to have a pleasant, fruity aroma and may be used as artificial flavors (Kumar et al., 2010). Esters contain anti-fibrotic, gastro-protective, anti-diabetic, cardio-protective, antioxidant, immune-stimulatory, and anti-inflammatory properties (Alagbe, 2022).

Table 2: Major bioactive compounds of *Carica papaya* essential oil using gas chromatography and mass spectrometry.

Compounds	Retention Time (minutes)	Percentage concentration	Molecular weight (gram/mole)	Molecular formula
Myrcene	7.113	5.66	136	$C_{10}H_{16}$
α-pinene	8.662	10.71	136	$C_{10}H_{16}$
α-terpineol	8.990	8.05	154	$C_{10}H_{15}O$
Limonene	10.461	11.26	136	$C_{10}H_{16}$
Linalool	11.228	4.32	154	$C_{10}H_{15}O$
Carvone	12.006	2.75	150	$C_{10}H_{14}O$
Geranyl acetate	12.114	1.41	196	$C_{13}H_{24}O$
α-terpinyl acetate	12.556	3.06	196	$C_{12}H_{20}O_3$
Benzyl acetate	13.209	1.22	150	$C_9H_{10}O_2$
2-methyl propyl acetate	13.421	0.96	234	$C_{15}H_{22}O_2$
Oxacyclohexadec-2-one	13.566	0.80	238	$C_{15}H_{22}O_2$
Cis-methyl dihydrojasmonate	15.190	1.33	226	$C_{13}H_{22}O_3$
n-Hexyl salicylate	15.612	0.96	222	$C_{13}H_{18}O_2$
Geraniol	17.008	1.40	154	$C_{10}H_{18}O$
γ-terpene	17.241	2.07	136	$C_{10}H_{16}$
Veloutone	17.882	1.54	196	$C_{13}H_{24}O$

4.2 Hematological results of broiler chicks fed diets supplemented with *Carica papaya* essential oil (0-56 d)

Hematological results of broiler chicks fed with *Carica papaya* essential oil (0-28 d) and (29-56 d) has been presented in Table 3 and 4 correspondingly. In the starting phase, pack hemoglobin, lymphocytes, monocytes, red blood cells, white blood cells, and cell volume, basophils, eosinophils, and neutrophil levels varied from 30.90 – 33.06 %, 9.33 – 9.65 g/dL, 2.25 – 2.26 (×1012/L), 10.02 – 10.88 (×109/L), 70.42 – 71.63 %, 1.88 – 2.00 %, 0.86 – 0.92 %, 1.00 – 1.50 % and 0.29 - 0.35 % sequentially. In the end phase (Table 4), PCV, red blood cell, Hb, RBC, WBC, lymphocytes, monocytes, basophils, eosinophils, and neutrophil levels varied between 33.06 - 39.42 %, 3.10 - 3.11 (×1012/L), 10.50 - 10.67 g/dL, 11.30 - 11.40 (×109/L), 73.10 - 73.18 %, 2.10 - 2.18 %, 0.86 - 0.87 %, 1.50 - 1.51 % and 0.55 - 0.57 % respectively. Dietary supplementation of *Carica papaya* essential oil did not affect the parameters (P>0.05).

Table 3: Hematological results of broilers fed diets supplemented with *Carica papaya* essential oil (0 – 28 d)

Constituents	Group 1	Group 2	Group 3	Group 4
Pack cell volume (%)	30.90 ± 0.60	33.06 ± 1.80	31.92 ± 2.00	30.96 ± 0.97
Haemoglobin (g/dL)	9.50 ± 0.29	9.33 ± 0.66	9.90 ± 1.20	9.65 ± 1.10

Red blood cell (×1012/L)	2.25 ± 0.25	2.26 ± 0.25	2.26 ± 0.25	2.26 ± 0.25
White blood cell (×109/L)	10.56 ± 0.50	10.02 ± 0.00	10.80 ± 0.22	10.88 ± 0.31
Lymphocytes (%)	71.63 ± 2.50	70.42 ± 1.89	70.80 ± 1.00	71.36 ± 1.33
Monocytes (%)	1.92 ± 1.00	1.88 ± 0.30	1.86 ± 0.35	2.00 ± 0.50
Basophils (%)	0.92 ± 0.12	0.86 ± 0.10	1.00 ± 0.13	0.90 ± 0.00
Eosinophils (%)	1.00 ± 0.10	1.00 ± 0.15	1.50 ± 0.39	1.20 ± 0.22
Neutrophils (%)	0.30 ± 0.01	0.29 ± 0.00	0.35 ± 0.01	0.31 ± 0.01

T1: Standard feed with no papaya essential oils; T2: Standard feed plus 100 mg/kg papaya essential oil; T3: Standard feed plus 200 mg/kg papaya essential oil; T4: Standard feed plus 300 mg/kg *Carica papaya* essential oil.

Table 4: Hematological results of broilers fed diets supplemented with *Carica papaya* essential oil (29 – 56 d)

Constituents	Group 1	Group 2	Group 3	Group 4
Pack cell volume (%)	33.90 ± 2.00	33.06 ± 2.00	34.92 ± 2.11	33.96 ± 2.02
Haemoglobin (g/dL)	10.50 ± 0.60	10.67 ± 0.65	10.60 ± 0.67	10.65 ± 0.60
Red blood cell ($\times 10^{12}$/L)	3.11 ± 0.32	3.10 ± 0.29	3.11 ± 0.32	3.11 ± 0.32
White blood cell ($\times 10^{9}$/L)	11.30 ± 0.70	11.40 ± 0.70	11.40 ± 0.70	11.40 ± 0.70
Lymphocytes (%)	73.18 ± 2.50	73.10 ± 2.50	73.11 ± 2.50	73.16 ± 2.50
Monocytes (%)	2.10 ± 0.50	2.18 ± 0.50	2.16 ± 0.55	2.15 ± 0.66
Basophils (%)	0.86 ± 0.02	0.87 ± 0.02	0.87 ± 0.02	0.87 ± 0.02
Eosinophils (%)	1.51 ± 0.38	1.50 ± 0.38	1.50 ± 0.39	1.50 ± 0.39
Neutrophils (%)	0.55 ±0.00	0.55 ± 0.00	0.57 ± 0.01	0.55 ± 0.01

T1: Standard feed with no papaya essential oils; T2: Standard feed plus 100 mg/kg papaya essential oil; T3: Standard feed plus 200 mg/kg papaya essential oil; T4: Standard feed plus 300 mg/kg *Carica papaya* essential oil.

4.3 Serum biochemical results of broilers fed diets supplemented with *Carica papaya* essential oil (0-56 days)

Serum biochemical results of chicks fed diets supplemented with *Carica papaya* essential oil at the starter phase (0-28 days) and finisher phase (29-56 days) are presented in Tables 4 and 5 respectively. In the starter phase, total protein (Tp), globulin (Glo), albumin (Alb), creatinine (Crt), triglycerides (Try), alanine phosphatase (ALP), and aspartic transferase (AST) values were not influenced (P>0.05) by the treatments except for higher cholesterol levels (P<0.05) in diet 1 than in other groups. In the finisher phase, total protein, globulin, albumin, creatinine, triglycerides, alanine transaminase, ALP, and cholesterol levels ranged from 7.08 - 7.28 g/dL, 3.02 - 3.10 g/dL, 4.06 - 4.22 g/dL, 0.90 - 0.96 mg/dL, 140.1 - 151.2 mg/dL, 95.22 - 97.06 mg/dL, 37.06 - 38.88 (U/L) 123.0 - 123.5 (U/L) and 140.1 - 151.2 mg/dL respectively. Tp, Glo, Alb, Crt, triglycerides, ALP, and AST values were among the group (P>0.05). Conversely, cholesterol levels were affected by the dietary supplementation of *Carica papaya* essential oil (P<0.05).

Table 4: Serum biochemical results of chicks fed diets supplemented with *Carica papaya* essential oil (0– 28 d)

Constituents	Group 1	Group 2	Group 3	Group 4
Total protein (g/dL)	6.23 ± 0.06	6.35 ± 0.07	6.30 ± 0.04	6.26 ± 0.03
Globulin (g/dL)	2.36 ± 0.17	2.45 ± 0.22	2.42 ± 0.19	2.46 ± 0.17
Albumin (g/dL)	3.87 ± 0.26	3.90 ± 0.30	3.88 ± 0.24	3.28 ± 0.25
Creatinine (mg/dL)	1.33 ± 0.12	1.25 ± 0.10	1.28 ± 0.10	1.30 ± 0.11
Cholesterol (mg/dL)	143 ± 12.0^{a}	135 ± 9.33^{b}	132 ± 9.50^{b}	130 ± 9.88^{b}
Triglycerides (mg/dL)	90.10 ± 8.80	88.10 ± 7.31	88.75 ± 7.50	88.60 ± 7.12
AST (U/L)	110 ± 37.22	102 ± 35.18	106 ± 35.00	102 ± 36.02
ALP (U/L)	27.96 ± 6.77	26.28 ± 5.80	25.92 ± 5.10	25.16 ± 5.52

beans with different superscripts along a row are significantly (P<0.05) different; SEM: standard error of the mean; T1: Standard feed with no papaya essential oils; T2: Standard feed plus 100 mg/kg *Carica papaya* essential oil; T3: Standard feed plus 200 mg/kg *Carica papaya* essential oil; T4: Standard feed plus 300 mg/kg *Carica papaya* essential oil.

Table 5: Serum biochemical results of chicks fed diets supplemented with *Carica papaya* essential oil (29 – 56 d)

Constituents	Group 1	Group 2	Group 3	Group 4
Total protein (g/dL)	7.08 ± 0.40	7.28 ± 0.51	7.28 ± 0.50	7.27 ± 0.48
Globulin (g/dL)	3.02 ± 0.10	3.10 ± 0.12	3.08 ± 0.16	3.05 ± 0.18
Albumin (g/dL)	4.06 ± 0.06	4.18 ± 0.08	4.20 ± 0.10	4.22 ± 0.12
Creatinine (mg/dL)	0.96 ± 0.00	0.93 ± 0.00	0.90 ± 0.00	0.92 ± 0.00
Cholesterol (mg/dL)	151.2 ± 13.88[a]	143.1 ± 13.92[b]	141.8 ± 14.02[b]	140.1± 14.0[b]
Triglycerides (mg/dL)	97.06 ± 4.88	95.22 ± 3.10	96.31 ± 3.80	96.02 ± 4.71
AST (U/L)	123.5 ± 39.60	123.7 ± 39.00	123.1 ± 38.86	123.0 ± 39.00
ALP (U/L)	38.88 ± 6.33	37.06 ± 5.72	37.96 ± 6.07	38.00 ± 6.18

beans with different superscripts along a row are significantly (P<0.05) different; SEM: standard error of the mean; T1: Standard feed with no papaya essential oils; T2: Standard feed plus 100 mg/kg *Carica papaya* essential oil; T3: Standard feed plus 200 mg/kg *Carica papaya* essential oil; T4: Standard feed plus 300 mg/kg *Carica papaya* essential oil.

5. Discussion

Blood parameters are used to determine an animal's health state (Livingstone et al., 2019a). In this experiment, hematological parameters determined in both the start and end phases were within the established ranges for healthy birds (Merck Veterinary Manual, 2010; Livingston et al., 2019a) indicating the absence of inflammation, infection, malnutrition, and deterioration in animal physiology. Normal PCV, Hb, and RBC levels suggested that the birds were not anemic giving room for an efficient supply of oxygen and nutrient utilization (Alagbe et al., 2023; Adewale et al., 2021). Essential oils are reported to promote growth performance and blood indices of birds (Muritala et al., 2022; Oluwafemi et al., 2022). This study showed that the presence of limonene and α-pinene which were the most prominent bioactive compounds in *Carica papaya* essential oil did not negatively affect the system in any way of birds and were also within the tolerable level to enhance their regular overall health (Olafadehan et al., 2021). Haemoglobin is responsible for the movement of carbon dioxide returns from the tissues to the lungs, and oxygen returns from the lungs to the tissues. (Livingston et al., 2019b). According to Birkova et al. (2017) states that white blood count is at a good level in birds. A low RBC rate may indicate bone marrow damage, hemorrhagic infections, vitamin B12 deficiency, metabolic disorders, chronic inflammation, iron deficiency, and gastrointestinal infections amongst others (Alagbe, 2022).

WBCs are cells of the immune system that are involved in protecting the body against both infectious diseases and pathogens (Livingstone et al., 2019a). Neutrophils are involved in the destruction of bacteria and release chemicals that kill or inhibit the growth of pathogens (Alagbe et al., 2021). Monocytes change into macrophages in the tissues where it cleans up cells by phagocytosis (Zonrawi et al., 2012; Obikaonu et al., 2012). Basophils defend the body from allergens, pathogens, and parasites (Alagbe et al., 2023; Adeyemi et al., 2000). It also releases histamine, and herpatin to improve blood flow and prevent blood clots (Steel and Torrie, 1980). Lymphocytes are saddled with the production of antibodies to prevent diseases (Sobayo et al., 2013; Thrall, 2007).

The results on serum indices in both the starting and growing phases revealed that findings were within the normal range for healthy chickens reported by Jain (1993). Total protein measurements can reflect nutritional status, kidney and liver disease, or any other health condition (Alagbe, 2021; Bounous and Stedman, 2000). The outcome of this experiment suggests that the nutritional requirements of the experimental birds were met and the supplementation of *Carica papaya* essential oil was within the permissible range for birds. Albumin is synthesized in the liver, carries substances (hormones, vitamins, and enzymes) throughout the body, and maintains oncotic pressure in the blood (Banerjee, 2004; AMTL, 2001). Low albumin levels in the serum might be a result of inflammations, infections, or liver diseases (Café, 2012; Nworgu et al., 2007). Globulins give an insight into the nutritional status and immune function of birds (Jain, 1993; Islam, 2004). Creatinine is a waste product from the normal breakdown of muscle tissues (Alagbe, 2021). High levels of creatinine in the blood suggest renal failure (Omokore and Alagbe, 2019). AST can be found in the liver, brain, pancreas, heart, kidneys, lungs, and skeletal muscles of animals (Olafadehan et al., 2021). Extremely high AST levels may be a sign of cardiac issues, cirrhosis, hepatitis., pancreatitis, or toxicity (Oluwafemi et al., 2021). ALP is an enzyme found throughout the body, but it is mostly found in the liver, bones, kidney, and digestive systems (Shittu et al., 2021). Elevated ALP levels suggest an obstruction of the liver and blockage of bile ducts while low levels indicate malnutrition, magnesium, and zinc deficiency (Alagbe, 2021). Cholesterol levels were higher in diet 1 relative to the other treatments, this suggests that *Carica papaya* essential oil can avert the dangers of excessive fats in the meat of birds, modulating the fatty acid profile as well as improving the shelf life of products, this will prevent cardiovascular diseases and promote food safety among consumers.

6. Conclusion

In conclusion, *Carica papaya* essential oils contain several bioactive compounds with pharmacological benefits, such as hepato-protective, antioxidant, antibacterial, antifungal, antimicrobial, anti-inflammatory, immuno-stimulatory, hepato-protective, and antioxidant properties amongst others. Broiler diets may include up to 300 mg/kg of it without compromising their body physiology and health status.

7. References

Mohammed A.B.R, Zakaria, Z, Sreenivasan, S., Lachimanan, Y.L, Santhanam, A. (2010). Assessment of Euphorbia hirta L. Leaf, Flower, Stem, and Root Extracts for their Antibacterial and Antifungal Activity and Brine Shrimp Lethality. Journal of Ethnopharmacology. 2010; 8:420-449.

Ghosh, P., Das, P., Das C, Mahapatra, S and Chatterjee, S. (2018). Morphological Characteristics and Phyto-pharmacological Detailing of Hatishur (Heliotropium Indicum Linn.): A Concise Review. Journal of Pharmacognosy and Phytochemistry, 7(5): 1900-1907: 2278-4136.

Huang L, Chen, S and Yang, M. (2012). Euphorbia hirta (Feiyangcao): A Review on Its Ethnopharmacology, Phytochemistry and Pharmacology. Journal of Medicinal Plants Research, 6(39):5176-5185:1996- 0875.

Kumar, S, Malhotra, R and Kumar, D. (2010). Euphorbia hirta: Its Chemistry, Traditional and Medicinal Uses and Pharmacological Activities. Pharmacognosy, 4(7):58–61.

World Health Organization (1991). "Guidelines for Assessment of the Herbal Medicines". Program on Traditional Medicine. WHO, Geneva, 1991:56-91.

Kritas, S.K and Morrison, R.B. (2004). Can probiotics substitute for sub-therapeutic antibiotics? Proceedings of the 18th International Pig Veterinary Society Congress, Hamburg: 739.

Peter, K. (2021). Phytogenics: successful AGP replacement in swine diets. International Pig Magazine, 2(2): 1-3.

Jain, N. C. (1993). Essentials of Veterinary Haematology, 4th Edition. Lea and Febiger, Philadelphia, U.S.A. Jain, N. C. (1986). Schalm's Veterinary Haematology. 4th Edition, Lea and Febiger, Philadelphia. Kaneko, J. J. (1997). Serum Proteins and the Dysproteinemias. In Clinical Biochemistry of Domestic Animals. 5th Edition

Islam, M. S., Lucky, N. S., Islam, M. R., Ahad, A., Das, B. R., Rahman, M. M and Siddivi, M. S. I. (2004). Hematological parameters of Fayoumi, Assil, and local chickens reared in Sylhet Region in Bangladesh. International Journal of Poultry Science, 4(10), 748−756.

Café, M. B., Rinaldi, F. P., Morais, H. R., Nascimento, M. R., Mundim, A. V and Marchini, C. F. P. (2012). Biochemical blood parameters of broilers at different ages under a thermoneutral environment. World Poultry Conference, Salvador-Bahia-Brazil, 5−9 August, 2012. World Poultry Science Journal, Suppl. 1, pp. 143−146.

Benerjee, G. C. (2004). A Textbook of Animal Husbandry. 8th Ed. Oxford and IBH Pub. Co., PVT., LTD.

Bounous, D. L. & Stedman, N. L. (2000). Normal Avian Haematology: Chicken and Turkey. In Feldman, B. F., Zinkl, J. G. and N. C. Jain, Lippin Cotts, Williams and Wilkins, Philadelphia, pp. 1147−1154.

Adeyemi, O. A., Fashina, O. E. & Balogun, M. O. (2000). Utilization of full-fat Jatropha seed in Broiler Diet: Effect on Haematological Parameters and Blood Chemistry. In Proceedings of 25th Annual Conference of Nigerian Society Animal Production (NSAP), 19th - 23rd March 2000, Umudike, pp. 108−109.

American Metabolic Testing Laboratories, Inc. Chemistry Profile. (2001). www.caprofile.net/t3.html.

Nworgu, F. C., Ogungbenro, S. A. and Solsi, K. S. (2007). Performance and some blood chemistry indices of broiler chickens served fluted pumpkin (Telfaria occidentalis) leaves extract supplement. American Eurasian Journal of Agricultural and Environmental Science, 2(1), 90−98.

Obikaonu, H. O., Okoli, I. C., Opera, M. N., Okoro, V. M. O., Ogbuewu, I. P., Etuk, E. B and Udedibie, A. B. I. (2012). Hematological and serum biochemical indices of starter broilers fed leaf neem (Azadirachta indica). Journal of Agricultural Technology, 8(1), 71−79.

Zomrawi, W. B., Abdel Atti, K. H. A., Dousa, B. M, and Mahala, A. G. (2012). The effect of ginger root powder (Zingiber officinale) supplementation on broiler chicks' performance, blood and serum constituents. Online Journal Animal Feed Researches, 2(6), 457−460.

Sobayo, R. A., Adeyemi, O. A., Oso, A. O., Fafiolu, A. O., Daramola, J. O., Sodipe, G., Ogunade, I. B and Odetola,

O. M. (2013). Haematological, Serum, and Carcass characteristics of broiler chicken fed graded levels of Garcinia kola (Bitter kola) used as phytobiotic. Nigeria Journal of Animal Production, 40(1), 48−56.

Steel, T. G. O, and Torrie, L. H. (1980). Principles and Procedures of Statistics. A Biometrical Approach. 2nd Edition, Mc Graw-Hill Book Company, New York.

Thrall, M. A. (2007). Hematologia e Bioquimica Clinica Veterinaria. Philadelphia: Lippincott Williams & Wilkins, Sao Paulo: Roca, 582 pp

NRC (1994). National Research Council. Nutrient Requirements of Poultry, eighth ed. National Academic Press, Washington, DC.

Okotie-Eboh, G.O., Kubena, L.F., Chinnah, A.D., Bailey, C.A (1997). Effects of beta-carotene and canthaxanthin on aflatoxicosis in broilers. Poultry Sci. 76, 1337–1341.

Livingston, M.L., Ferket, P.R., Brake, J., Livingston, K.A. (2019a). Dietary amino acids under hypoxic conditions exacerbates muscle myopathies including wooden breasts and white striping. Poultry Sci. 98, 1517–1527.

Livingston, Matthew L., Landon, C., Barnes, H.J., Brake, J. (2019b). White striping and wooden breast myopathies of broiler breast muscle are affected by time-limited feeding, genetic background, and egg storage. Poultry Sci. 98, 217–226

Muritala, Daniel Shittu., Alagbe, J.O., Ojebiyi, O.O., Ojediran, T.K and Rafiu, T.A. (2022). Growth performance and hematological and serum biochemical parameters of broiler chickens given varied concentrations of Polyalthia longifolia leaf extract in place of conventional antibiotics. Animal Science and Genetics 18(2): 57-71.

Alagbe John Olujimi, Oluchi, C.P Agubosi and Rufus Adebisi Oluwafemi (2023). Histopathology of broiler chickens fed diets supplemented with Prosopis africana (African mesquite) essential oil. Brazilian Journal of Science, 2(9): 49-59.

Alagbe John Olujimi, Ramalan Sadiq Muhammad., Shittu Muritala Daniel, and Olagoke Olayemi Christiana (2022). Effect of Trichilia monadelphous stem bark extract on the fatty acid composition of rabbit's thigh meat. Journal of Environmental Issues and Climate Change 1(1): 63-71.

Alagbe, J.O., Shittu, M.D and Tanimomo, Babatunde K. (2022). Influence of Anogeissusleio carpus stem bark on the fatty acid composition in the meat of broiler chickens. European Journal of Life Safety and Stability 14(22): 13-22.

Alagbe, J.O (2022). Use of medicinal plants as a panacea to poultry production and food security: A review. Gospodarka I Innowacje 22(2022): 1-12.

Singh Sharma., Alagbe Olujimi John., Liu Xing., Sharma Ram, and Kumar Amita (2022). Comparative analysis of ethanolic Juniperus thurifera leaf, stem bark, and root extract using gas chromatography and mass spectrometry. International Journal of Agriculture and Animal Production, 2(6): 18-27.

Agubosi, O.C.P., Alexander, James and Alagbe, J.O. (2022). Influence of dietary inclusion of Sunflower (Helianthus annus) oil on growth performance and oxidative status of broiler chicks. Central Asian Journal of Medical and Natural Sciences 2(7): 187-195.

Alagbe, J.O. (2022). Gas chromatography and mass spectroscopy of Juniperus phoenice stem bark extract and its influence on the haemato-biochemical values of growing rabbits. British Scientific Periodical 1(1): 18-33.

Alagbe, J.O. (2022). Prosopis africana (African mesquite) oil as an alternative to antibiotic feed additives on broiler chickens diets: hematology and serum biochemical indices. Central Asian Journal of Theoretical and Applied Sciences 3(2): 19-29.

Alagbe, J.O (2021). Dietary Supplementation of Rauvolfia Vomitoria Root Extract as A Phytogenic Feed Additive in Growing Rabbit Diets: Growth Performance and Caecal Microbial Population. Concept in Dairy and Veterinary Sciences. 4(2):2021.

Adewale, A.O., Alagbe, J.O., Adeoye, Adekemi. O. (2021). Dietary Supplementation of Rauvolfia Vomitoria Root Extract as A Phytogenic Feed Additive in Growing Rabbit Diets: Haematology and serum biochemical indices. International Journal of Orange Technologies, 3(3): 1-12.

Singh, A.S., Alagbe, J.O., Sharma, S., Oluwafemi, R.A and Agubosi, O.C.P. (2021). Effect of dietary supplementation of melon (Citrallus linatus) seed oil on the growth performance and antioxidant status of growing rabbits. Journal of Multidimensional Research and Reviews, 2(1): 78-95.

Shittu, M.D., Alagbe, J.O., Adejumo, D.O., Ademola, S.G., Abiola, A.O., Samson, B.O and Ushie, F.T. (2021).

Productive Performance, Caeca Microbial Population and Immune-Modulatory Activity of Broiler Chicks Fed Different Levels Sida Acuta Leaf Extract in Replacement of Antibiotics. Bioinformatics and Proteomics Open Access Journal 5(1): 000143.

Alagbe, J.O. (2021). Prosopis africana stem bark as an alternative to antibiotic feed additives in broiler chicks diets: Performance and Carcass characteristics. Journal of Multidimensional Research and Reviews, 2(1): 64-77.

Alagbe, J.O. (2021). Daniella oliveri leaf extracts as an alternative to antibiotic feed additives in broiler chicken diets: Meat Quality and Fatty acid composition. Indonesian Journal of Innovation and Applied Sciences 1(3): 177-186.

Oluwafemi, R.A., Uankhoba, I.P and Alagbe, J.O. (2021). Effects of turmeric oil as a dietary supplement on the growth performance and carcass characteristics of broiler chicken. International Journal of Orange Technologies, 3(4): 1-9.

Oluwafemi, R.A., Uankhoba, I.P and Alagbe, J.O. (2021). Effects of turmeric oil as a dietary supplement on the hematology and serum biochemical indices of broiler chickens. Bioinformatics and Proteomics Open Access Journal 5(1): 000138.

Musa, B., Alagbe, J.O., Adegbite Motunrade Betty, Omokore, E.A. (2020). Growth performance, caeca microbial population and immune response of broiler chicks fed an aqueous extract of Balanites aegyptiaca and Alchornea cordifolia stem bark mixture. United Journal for Research and Technology, 2(2):13-21.

Olafadehan, O.A., Oluwafemi, R.A and Alagbe, J.O. (2020). Performance, haemato-biochemical parameters of broiler chicks were administered Rolfe (Daniellia Oliveri) leaf extract as an antibiotic alternative. Advances in Research and Reviews, 2020, 1:4.

Olafadehan, O.A., Oluwafemi, R.A and Alagbe, J.O. (2020). Carcass quality, nutrient retention, and caeca microbial population of broiler chicks administered Rolfe (Daniellia oliveri) leaf extract as an antibiotic alternative. Journal of Drug Discovery. 14(33):146-154.

Aravind G, Debjit B, Duraivel S, Harish, G. (2013). Traditional and Medicinal Uses of Carica papaya. Journal of Medicinal Plants Studies. ISSN: 2013, 2320-3862.

Pungasari, S.M.; Abdulkarim; Ghazali, H.M. (2005). Properties of *Carica papaya* L. (Papaya) Seed Oil Following Extraction Using Solvent and Aqueous Enzymatic Methods. Journal of Food Lipids, 12(1): 62–76.

Owoyele, B.V.; Adebukola, O.M.; Funmilayo, A.A.; Soladoye, A.O. (2008). Anti-inflammatory activities of ethanolic extract of *Carica papaya* leaves. Inflammopharmacology, 16: 168–173.

Aruoma, O.I.; Colognato, R.; Fontana, I.; Gartlon, J.; Migliore, L.; Koike, K.; Coecke, S.; Lamy, E.; Mersch-Sundermann, V.; Laurenza, I. (2006). Molecular effects of fermented papaya preparation on oxidative damage, MAP Kinase activation, and modulation of the benzo[a]pyrene mediated genotoxicity. Biofactors, 26: 147–159.

Raffaelli, F.; Nanetti, L.; Montecchiani, G.; Borroni, F.; Salvolini, E.; Faloia, E.; Ferretti, G.; Mazzanti, L.; Vignini, A. (2015). In vitro effects of fermented papaya (Carica papaya, L.) on platelets obtained from patients with type 2 diabetes. Nutrition Metabolism Cardiovascular Disease, 25: 224–229.

Juárez-Rojop, I.E.; Díaz-Zagoya, J.C.; Ble-Castillo, J.L.; Miranda-Osorio, P.H.; Castell-Rodríguez, A.E.; Tovilla-Zárate, C.A.; Rodríguez-Hernández, A.; Aguilar-Mariscal, H.; Ramón-Frías, T.; Bermúdez-Ocaña, D.Y. (2012). Hypoglycemic effect of *Carica papaya* leaves in streptozotocin-induced diabetic rats. BMC Complementary Alternative Medicine, 12(12) 236-238.

Saliasi, I.; Llodra, J.C.; Bravo, M.; Tramini, P.; Dussart, C.; Viennot, S.; Carrouel, F. (2018). Effect of a Toothpaste/Mouthwash Containing *Carica papaya* Leaf Extract on Interdental Gingival Bleeding: A Randomized Controlled Trial. International Journal of Environmental Research in Public Health, 18 (5): 2660 - 2665.

Mikhal'chik, E.V.; Ivanova, A.V.; Anurov, M.V.; Titkova, S.M.; Pen'kov, L.Y.; Kharaeva, Z.F.; Korkina, L.G. (2004). Wound-healing effect of papaya-based preparation in experimental thermal trauma. Bulletin on Experimental Biology, 137: 560–562.

García-Solís, P.; Yahia, E.M.; Morales-Tlalpan, V.; Díaz-Muñoz, M. (2009). Screening of antiproliferative effect of aqueous extracts of plant foods consumed in México on the breast cancer cell line MCF-7. International Journal of Food Science and Nutrition, 60 (Suppl. S6): 32–46.

Somanah, J.; Ramsaha, S.; Verma, S.; Kumar, A.; Sharma, P.; Singh, R.K.; Aruoma, O.I.; Bourdon, E.; Bahorun,

T. (2016). Fermented papaya preparation modulates the progression of N-methyl-N-nitrosourea-induced hepatocellular carcinoma in Balb/c mice. Life Science, 151: 330–338.

Nayak, B.S.; Ramdeen, R.; Adogwa, A.; Ramsubhag, A.; Marshall, J.R. (2012). Wound-healing potential of an ethanol extract of *Carica papaya* (Caricaceae) seeds. International Wound Journal, 9: 650–655.

Burla, S., Venkata, S., Malati, A., Nancy G. R., Swetha, M and Vivek Sharma. (2018). Studies on physicochemical properties and proximate analysis of *Carica papaya* seed. Journal of Pharmacognosy and Phytochemistry, 7(6): 1514-1519.