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## Review Article

# Chicory (*Cichorium intybus*) Herb: Chemical Composition, Pharmacology, Nutritional and Healthical Applications

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## Abstract

Chicory (*Cichorium intybus*) is a perennial herbal plant of the dandelion family Asteraceae, usually with bright blue flowers, rarely pink or white. Several varieties are cultivated for salad leaves, chicons or roots which are baked, ground and used as a coffee substitute and supplement. It is also grown as a forage plant for poultry and animal. In addition, chicory herb plays a key role as antioxidant, anti-inflammatory, sedative, immunological, productive and reproductive enhancer, cardiovascular, hypolipidemic, anticancer, anti-protozoal, gastroprotective, antidiabetic, analgesic, anthelmintic, antimicrobial, wound healing and bitter tonic without inducing therapeutic adverse effect. Regarding the hepatoprotective activity, chicory extract reduced the levels of hepatic enzymes such as alanine aminotransferase (ALT), aspartate aminotransferase (AST) and alkaline phosphatase (ALP). Also, chicory plant is a good and very important protective source for hepatocytes and other liver cells as well as it is used as prebiotic against some species of pathogenic bacteria for both *in vitro* and *in vivo*. Moreover, it enhances immunity and feed efficiency by decreasing pathogenic microorganisms of gastrointestinal tract. *Cichorium intybus* roots also were used for the relief of mild digestive disorders, such as feeling of flatulence, abdominal fullness, temporary loss of appetite and slow digestion. The present study highlights the importance of chicory as a feed additive used to improve growth and productive performance of poultry as well as salient beneficial applications in animals and humans. Furthermore, it explains the mechanisms of action underlying the beneficial effects of chicory and to find the effective level in poultry that would act as liver tonic.

**Key words:** *Cichorium intybus*, pharmacology, nutrition, health, animal, poultry, humans

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**Data Availability:** All relevant data are within the paper and its supporting information files.

## INTRODUCTION

Many countries tend to prevent the application of traditional antibiotics as feed additives for their side effects on both poultry and animals. The ban on nutritive antibiotic use in the world and the augmented awareness of the consumers triggered a need for safe and natural supplements to achieve the best production of livestock animal; therefore, now a days growth enhancers from herbal sources are used very commonly<sup>1,2</sup>. Among several herbal plants, chicory (*Cichorium intybus*) is a valuable plant could be used as a natural liver tonic in poultry feed. Since, poultry is one of the largest industry which fulfill consumer's protein demand. The incredible growth of poultry industry in the world was due to diseases control, feed manipulation as well as genetic and managerial improvements. Various strategies have been used to enhance the broilers growth performance, feed utilization and economics. Among these strategies, use of antibiotics as growth promoters is most chosen one. Even in developing countries like Pakistan approximately, one billion rupees were used by poultry industry annually for antibiotics which increased feed bag cost around 100-150 rupees per bag<sup>3</sup>. In some countries, the use of antibiotics as feed additive is banned due to the massive insecurity in food because these antibiotics develop resistance in animals and humans against several diseases<sup>4</sup>. Consumer awareness of the relationship between poultry feed formulations and human health enhanced the demand for poultry meat free of antibiotic residues. Moreover, there are many factors such as development in technology and sciences, enhancement of cost in healthcare and alterations in laws of food play important roles in increasing the demand of functional foods. Now a days, poultry scientists are looking forward to find some alternative sources for antibiotic to minimize its side effects in animal and humans and enhance immunity and feed efficiency by decreasing pathogenic microorganisms of gastrointestinal tract.

Different parts of herbal medicinal plants and plant extracts such as black cumin<sup>5</sup>, quercetin plant derived product<sup>6</sup> and chicory<sup>7,8</sup> have been used in poultry feed as growth promoters but with varying results. These plants have many properties such as growth promoter, anti-bacterial, anti-fungal, anti-cancer, anti-tumor, anti-malarial, anti-coccidial, gastro-protective, diuretic and immunogenic<sup>9</sup>. However, a few studies have suggested that the positive effects of chicory in different animal model but literature is lacking information about chicory used as hepatoprotective in poultry production and underlying mechanism. Therefore, the objective of this study shed lights on this medicinal

plant regarding the hepatoprotectant to overcome liver diseases and help to replace antibiotic with chicory and provide promising future used as herbal liver tonic in poultry industry to cope the medicinal cost.

**Plant profile and chemical compositions:** Chicory (*Cichorium intybus*) is herbaceous plant typically called kasni belongs to mono-generic family Asteraceae (Table 1) with various properties and usually grown in all over the world especially Pakistan. It is generally grown mixed with some other plants such as lucerne (*Medicago falcate*) and berseem (*Trifolium alexandrinum*)<sup>10</sup>. Chicory has several industrial uses i.e., best herbal diuretic and also helps in biomass production, strongest hepatoprotective agent, poultry feed additive and used as animal forage<sup>11,12</sup>. Along with medicinal properties the nutritional profile of kasni is also good because it has certain amount of vitamins (especially vitamin C) and minerals, different types of active compounds such as inulin, sesquiterpene lactones, fats, vitamins, minerals, fructans, mannitol and latex<sup>13-15</sup>. The proximate composition, vitamin and mineral contents of chicory herb are presented in Table 2. Some biological activities and medicinal effects of chicory (*Cichorium intybus*, *Cichorium frisee*, *Cichorium endivia*, *Cichorium grouse* and *Cichorium chico* and *Cichorium pumilum*) are illustrated in Fig. 1.

### Beneficial effects of chicory with special reference to its role as hepatoprotective agent:

The beneficial uses of chicory herb and its products in some different species are presented in Table 3. Chicory (*Cichorium intybus*) is an herbaceous plant commonly called kasni belongs to mono generic family, Asteraceae, with multifarious features; hepatoprotective, anti-inflammatory, antioxidant, sedative, immunological, reproductive, cardiovascular, hypolipidemic, anticancer, anti-protozoal, gastro-protective, antidiabetic, analgesic, anthelmintic, antimicrobial, wound healing and bitter tonic

Table 1: Botanical classification of *Cichorium intybus* leaves

Classification	Chicory herb
Kingdom	Plantae (plants)
Sub kingdom	Tracheobionta (Vascular plants)
Super division	Spermatophyta (Seed plants)
Division	Magnoliophyta (Flowering plants)
Order	Asterales
Suborder	Asterids
Family	Asteraceae (Eudicots family)
Sub family	Asteradeae
Tribe	Cichorieae
Genus	<i>Cichorium</i>
Species	<i>Indica C. intybus</i>
Botanical name	<i>Cichorium intybus</i>
English/local name	Chicory/Kasni

without inducing therapeutic adverse effect<sup>16</sup>. To make better use of chicory to assist in the development of powerful, hepatoprotective feed additive, it is necessary to understand the mechanism of action of this novel herbal plant as a liver tonic. To date, the process is underlying their hepatoprotective effects of chicory is not explored. Liver is a prime organ which performs many physiological functions in animals and poultry. The nutritional level of the birds is not only determined by what they eat but it depends on the function and processing of liver. Unluckily, it is very difficult to identify the early symptoms of liver imbalances and also longtime disorders due to the constant usage of antibiotics in broiler production as growth promoters<sup>17</sup>. Trease and Evans<sup>18</sup> mentioned that liver has complex chemistry and also plays an important function in the physiology of the bird by producing effective cures. There are some medicinal plants present similar to chicory having beneficial properties against hepatic disorders. Chicory is a good and very important protective source for hepatocytes. Clinical evaluation has also shown that it has ability to treat the liver problems<sup>19</sup>.

Chicory is used as prebiotic against some species of pathogenic bacteria for both *in vitro* and *in vivo*. Chicory increased feed consumption and improved immunity in broilers<sup>20,21</sup>. Previously, Mushtaq *et al.*<sup>22</sup> found that the hepatoprotective activity of aqueous-ethanolic extract of fresh dried leaves of chicory (*Cichorium intybus*) with given various concentrations was reported in comparison with silymarin treated animals. The significant effects were perceived in biochemical parameters regarding the liver enzymes such as alanine phosphatase (ALP), Serum Glutamate Oxaloacetate

Transaminase (SGOT), Serum Glutamate Pyruvate Transaminase (SGPT) and Total Bilirubin (TB) in rats. Chicory extract could inhibit skeletal muscle atrophy via inducing the expression of inhibiting the level of ceramide<sup>23</sup> and Hsp 70. Rasmussen<sup>24</sup> reported that feed supplementation of chicory could up-regulated hepatic androstenone metabolism, which can be a way of attracting a mate.

Table 2: Proximate analysis and mineral and vitamin composition of *Cichorium intybus* leaves

Nutrients	<i>Cichorium intybus</i>
Proximate analysis (g/100 g)	
Dry matter	81.7
Crude fiber	4.01
Carbohydrates	4.70
Crude protein	1.70
Ether extract	0.30
Metabolisable energy (kcal)	23.0
Mineral analysis (g/100 g)	
Magnesium	30.0
Phosphorus	47.0
Calcium	100
Zinc	0.33
Sodium	45.0
Iron	0.90
Vitamin analysis	
Vitamin A (µg)	286
Vitamin E (mg)	2.26
Vitamin K (µg)	296
Vitamin C (mg)	22.0
Vitamin B <sub>1</sub> (mg)	0.06
Vitamin B <sub>2</sub> (mg)	0.01
Vitamin B <sub>3</sub> (mg)	0.05
Vitamin B <sub>5</sub> (mg)	1.16
Vitamin B <sub>6</sub> (mg)	0.11
Vitamin B <sub>9</sub> (µg)	107

Table 3: Beneficial effects of *Cichorium intybus* in some species

Plant part	Traditional uses	Species	References
Aerial decoction	Liver disorders, spasmolytic, cholesterol, antiseptic	Human	Hanlidou <i>et al.</i> <sup>42</sup>
Chicory seeds	Liver disorders	Rats	Ahmed <i>et al.</i> <sup>63</sup>
Root	Jaundice, liver enlargement, gout and rheumatism cough relief	Rats	Pushparaj <i>et al.</i> <sup>64</sup>
Whole plant	Eupeptic, stomachic, depurative, choleric, laxative, hypotension, tonic and antipyretic	Human	Miraldi <i>et al.</i> <sup>65</sup>
Leaves	Blood cleansing	Human	Pieroni <sup>66</sup>
Leaves	High blood pressure and blood purification	Human	Guarrera <i>et al.</i> <sup>67</sup>
Leaves/roots	Arteriosclerosis, anti arthritis, antispasmodic, digestive	Human	Loi <i>et al.</i> <sup>68</sup>
Whorls	Depurative	Human	Pieroni <i>et al.</i> <sup>69</sup>
Leaves	Choleric, hepatoprotective against jaundice, mild laxative, hypoglycemic	Human	Leporatti and Ivancheva <sup>70</sup>
Aerial/roots	Renal disease	Human	Jouad <i>et al.</i> <sup>71</sup>
Whole plant	Kidney disorders and diabetes	Human	El-Hilaly <i>et al.</i> <sup>72</sup>
Roots	Diabetes	Human	Ahmad <i>et al.</i> <sup>73</sup>
Flower	Diarrhea	Human	Savikin <i>et al.</i> <sup>74</sup>
Aerial part/root	Cholagogue, digestive and hypoglycemic	Bacteria	Kokoska <i>et al.</i> <sup>75</sup>
Leaves, stems, roots	Jaundice and tonic	Human	Van Wyk <i>et al.</i> <sup>44</sup>
Leaf	Wound healing	Human	Sezik <i>et al.</i> <sup>76</sup>
Aerial	Hemorrhoids, urinary disorders	Human	Tetik <i>et al.</i> <sup>77</sup>

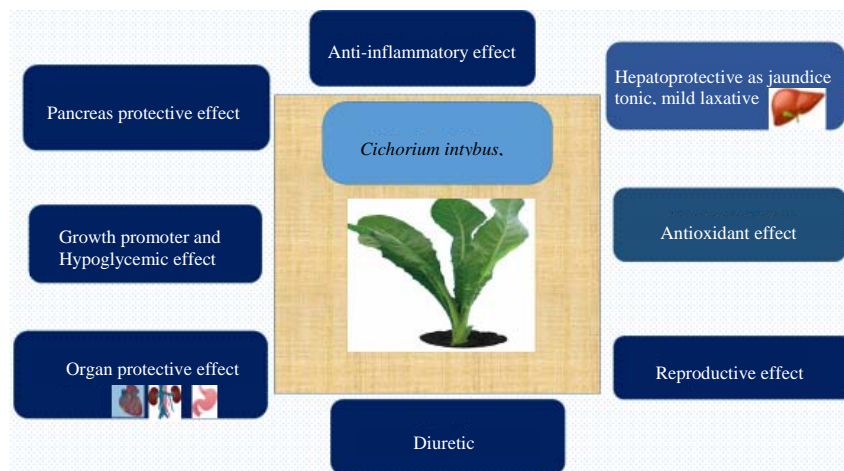


Fig. 1: Biological activities of chicory plant

Regarding anti-hepatotoxic properties of chicory, its extracts positively decreased the liver enzymes such as ALP, ALT and AST<sup>25</sup>. The significant decrease in ALT activity was also stated by Noreen<sup>25</sup>. While, Marzouk *et al.*<sup>26</sup> observed no significant impact chicory leaf extract on ALT activity. Abd El-Mageed<sup>27</sup> confirmed the hepatoprotective effect of celery leaves and chicory supplementation in barley based diet on hypercholesterolemic rats. It was reported that chicory leaves at 5% had beneficial effects on the hypercholesterolemia and liver diseases in rats. Chicory supplementation lowered total lipids, liver enzymes, bilirubin and total cholesterol<sup>28</sup>. On the other hand, Mishra and Kishore<sup>29</sup> observed the effects of kasni (*Cichorium intybus* Linn.) against dietary aflatoxicosis in rats. The researchers that supplementation of kasni (100 g kg<sup>-1</sup> feed) to diet contained 7 ppm aflatoxin B<sub>1</sub> decreased the activities of liver enzymes (GOT, ALP and GPT).

Gilani and Janbaz<sup>30</sup> pointed out that aqueous-methanolic extract of *Cichorium intybus* seeds at 500 mg kg<sup>-1</sup> in acetaminophen and CCl<sub>4</sub>-induced animals significantly lowered (p<0.01) the levels of serum liver enzymes like GOT, ALP and GPT to 228, 68 and 41 IU L<sup>-1</sup>, respectively. In addition, it also reduced the mortality rate up to 30% as compared to acetaminophen when supplemented at 1 g kg<sup>-1</sup> which caused 100% mortality in mice. In Wistar strain of Albino rats, Zafar and Ali<sup>31</sup> studied the hepatoprotective impact of natural root and root extracts of chicory herb against carbon tetrachloride (CCl<sub>4</sub>) induced hepatic disorders. The researchers found that chicory root or its extracts decreased the concentrations of serum liver enzymes (AST and ALT) and bilirubin in rats treated with CCl<sub>4</sub> in comparison with CCl<sub>4</sub> without additives. In another study, Gilani *et al.*<sup>32</sup> noted the protective effect of esculetin (phenolic compound) extract

from chicory and its role vs. paracetamol and CCl<sub>4</sub>-induced hepatic injury. It is observed that the pre-treatment of rats with esculetin at 6 mg kg<sup>-1</sup> lowered the mortality rate by 40% in comparison with paracetamol (1 g kg<sup>-1</sup>) group that recorded 100% mortality. In addition to, the oral administration of CCl<sub>4</sub> (1.5 mL kg<sup>-1</sup>) raised serum levels of ALP, AST and ALT but the tested level (6 mg kg<sup>-1</sup>) of esculetin was able to inhibit the CCl<sub>4</sub>-induced hepatic injury. In line, chicory root extract is rich in natural antioxidants and able to alleviate CCl<sub>4</sub>-induced hepatic damage by improving the antioxidant indices such as activity of glutathione peroxidase (GPx), glutathione s-transferase, catalase (CAT), glutathione reductase and paraoxonase-1 (PON1), removing reactive oxygen species and reducing lipid peroxidation<sup>33</sup>. Ahmed<sup>34</sup> stated that feeding with chicory plant has a substantial function in improving the antioxidant defense system by inducing gene expression and lowering the oxidative stress, thereby causing overexpression of CAT activity and restoring GSH concentration<sup>35</sup>.

Chicory, ginger and mixture of both in intoxicated rats showed positive effects regarding liver enzymes. Methanol extract of chicory (250 and 500 mg kg<sup>-1</sup>) alone or mixed with ginger (250 and 500 mg kg<sup>-1</sup>) showed no toxic symptoms even when doses<sup>36</sup> of CCl<sub>4</sub> were used up to 5 g kg<sup>-1</sup>. Similar reports were documented by other researchers who observed protective effects of chicory against oxytetracyclin-induced fatty liver and found that HDL, globulin, albumin, total protein and cholesterol were significantly decreased in chicory supplemented diets as compared to control group<sup>37</sup>. Mushtaq *et al.*<sup>22</sup> found that intoxicated rats fed diet containing dried leaves of chicory (100, 200 and 300 mg kg<sup>-1</sup> b.wt.) with silymarin (25 mg kg<sup>-1</sup>) significantly increased Serum Glutamate Oxaloacetate Transaminase (SGOT), glutamate pyruvate transaminase (SGPT), ALP and

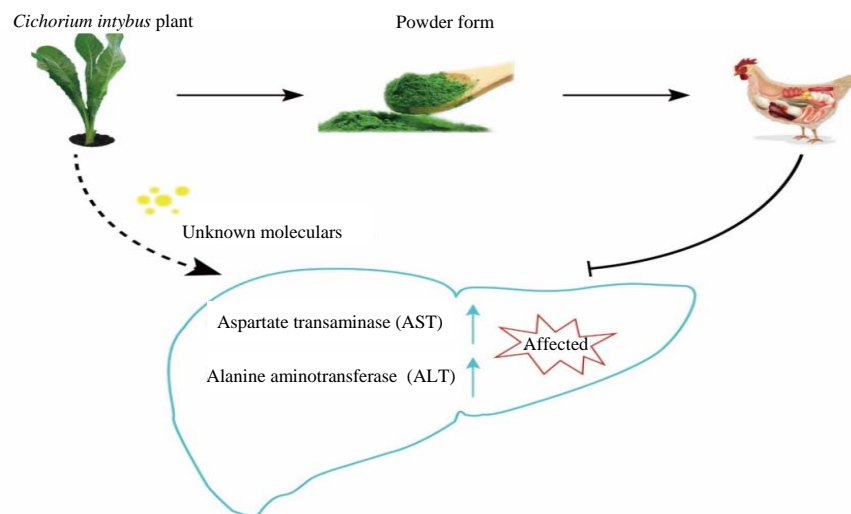


Fig. 2: Relationship between chicory herb and liver function, where dietary supplementation of chicory reduced the levels of hepatic enzymes in poultry birds

Total Bilirubin (TB) level. Cichorium root extract therapy was clearly observed by decreasing necrosis and glycogen content. Pronounced protein synthesis activity with increased the number of cells was observed in experimental rats with CCl<sub>4</sub>-induced hepatitis<sup>38</sup>. Similarly, in another study, different doses of chicory root extracts i.e., 150-450 or 200-500 mg kg<sup>-1</sup> day<sup>-1</sup> were supplemented in already CCl<sub>4</sub> induced liver toxicity in rats. Microvesicular steatosis and serum markers were significantly reduced in chicory (*Cichorium intybus*) groups<sup>39</sup>. Chicory fed diet offered to different animals exhibited greater Live Weight Gains (LWG) as compared to control diets<sup>40</sup>. Aqueous extracts of chicory herb showed bone protection vs. glucocorticoid-induced in rats<sup>41</sup>, this result may be attributed to containing flavonoids and inulin.

**Beneficial uses in human:** Since in ancient history various herbal plants had been used for their primary health problem. Hitherto, more attentions were being focused on plant-based remedies in traditional cultures and most important cures were carefully passed from one generation to other generation. In India, chicory seeds are used in commercial products (Jigrine) to treat of numerous liver diseases<sup>42</sup>. Anciently in Europe, *Cichorium intybus* roots were used for the relief of mild digestive disorders, such as feeling of flatulence, abdominal fullness, temporary loss of appetite and slow digestion<sup>43</sup>. Furthermore, in Africa, chicory's stems, leaves and roots are being used in a tea for the treatment of jaundice. The syrup of chicory is also used as a tonic for infants<sup>44</sup>. Moreover, the juice of this plant is used as a folk remedy for tumors and cancer of the uterus<sup>45</sup> and also

used for treatment of malaria destined having pound like lactucopicrin and lactones lactucin<sup>46</sup>.

**Practical applications in poultry and animal:** The beneficial activities of *Cichorium intybus* is presented in Table 4 and Fig. 2. Chicory forage (*Cichorium intybus*) is a unique dietary fiber source that has beneficial properties as fiber ingredient for poultry nutrition<sup>47</sup>. Saeed *et al.*<sup>8</sup> reported *Cichorium intybus* leaf extract as safe growth promoter, hepatoprotective and immune stimulator in broiler production. *Cichorium intybus* is a potentially convenient fiber-rich diet ingredient which improved palatability of diets in broilers<sup>48</sup>. Also, chicory forage has a high content of uronic acids, which in dicotyledonous plants derive from galactosyluronic acid; this acid is the building block in pectin<sup>49</sup>. In line, the chicory root contains a high level of inulin and fructooligosaccharides, which can be used to manipulate the composition of microbiota in the gastrointestinal tract and improves its integrity<sup>50</sup>. Inulin is one of the best sources of prebiotic in animal application<sup>51</sup>. Thus, both the root and forage of chicory are of interest as fiber sources in poultry nutrition.

Izadi *et al.*<sup>52</sup> observed that broiler fed *Cichorium intybus* root powder supplemented diets significantly improved growth performance by enhancing food digestion and absorption through alteration of jejunum histomorphometry. Beta fructans derived from chicory plant significantly reduced the serum cholesterol and abdominal fat in broiler<sup>53,54</sup>. In broiler chickens, feeding 4.5% chicory root powder lowered triglyceride and VLDL-cholesterol (very low-density lipoprotein) concentrations without adverse effects on

Table 4: Beneficial effects of *Cichorium intybus* on growth performance in poultry

Study model	Observations	References
Broiler	<i>Cichorium intybus</i> , at the rate 200 ppm kg <sup>-1</sup> improved the feed intake and increased daily weight gains	Jafari <i>et al.</i> <sup>78</sup>
Broiler	Addition of ethanol extract of chicory showed positive effect as hepatoprotective, antioxidant and reduction of uric acid to reduce heat stress	Khodadadi <i>et al.</i> <sup>79</sup>
Broiler	Chicory herb improved FCR and final weight gain	Velasco <i>et al.</i> <sup>80</sup>
Broiler	Addition of chicory forage in broilers diet increased performance and gut health of birds	Liu <i>et al.</i> <sup>48</sup>
Broiler	The combined effects of 0.014% β-glucan+0.7% <i>Cichorium intybus</i> inulin in broilers ration improved abdominal fat in this group	Elrayeh and Yildiz <sup>81</sup>
Broiler	Chicory lowered abdominal fat percentage as compared to other herbal supplemented	Jafari <i>et al.</i> <sup>78</sup>
Broiler	Addition of Ziziphora and chicory enhanced the carcass quality of broilers	Ali <sup>82</sup>
Broiler	They observed that lowest abdominal fat percentage and higher breast meat yield by the addition of chicory in the experimental diet	Rezaei <i>et al.</i> <sup>83</sup>
Broiler	Addition of chicory enhanced the carcass quality of broilers	Miao <i>et al.</i> <sup>84</sup>
Broiler	Birds treated with chicory did not show any strength of <i>E. coli</i> , lactobacilli and bifidobacteria. It also enhanced the feed digestibility	Nabizadeh <sup>85</sup>
Broiler	Lowered strength of <i>Clostridium</i> and <i>Salmonella</i> in GIT of the broilers fed diets supplemented with 5% of <i>Cichorium intybus</i>	Rehman <i>et al.</i> <sup>86</sup>
Broiler	Supplementation of chicory dried pulp in broilers enhanced the width and height of duodenal villi along with crypt depth and villus height ratio in the broilers	Awad <i>et al.</i> <sup>87</sup>
Broiler	Digestibility improved by addition of chicory in broiler feed	Yusrizal and Chen <sup>53</sup>
Broiler	Extracts of chicory decreased of liver enzymes. Consequently, it was reported that kasni seeds sustain anti-hepatotoxic property	Noreen <sup>25</sup>

chicken performance, while the total cholesterol, LDL-cholesterol (low-density lipoprotein) and HDL-cholesterol (high-density lipoprotein) were not affected by dietary supplementations<sup>55</sup>. In horses, Najafzadeh *et al.*<sup>56</sup> reported that the concentrations of AST, ALT, ALP and LDH, total and conjugated bilirubin, albumin and total protein were observed in the normal ranges whereas the concentration of uric acid was outside the normal range with *Cichorium intybus* supplementation. In another study, the blood non esterified fatty acids and urea nitrogen in dairy cows were not affected by chicory herb consumption for 12 weeks<sup>57</sup>. Furthermore, Lin *et al.*<sup>58</sup> and Zhu *et al.*<sup>59</sup> found that *Cichorium intybus* decreased serum uric acid concentration and inhibit liver xanthine oxidase and xanthine dehydrogenase.

Chicory is highly digestible for animal especially ruminants and has a low content of fiber. The roots of chicory are an excellent substitute for oats for animal due to their content of protein and fat. Also, this plant contains a low concentration of reduced tannins that may improve protein efficiency and reduce the intestinal parasites in animals. Large amounts of tannin could bind with proteins, resulting in low nutrient digestibility. Although this plant might have originated in Italy, France and India, much development of it for use with animal has taken place in New Zealand<sup>60-62</sup>.

## CONCLUSION AND FUTURE RECOMMENDATIONS

*Cichorium intybus* may be a good candidate for nutritional and pharmaceutical aspects in poultry and animals. The benefits of chicory supplementation as a natural additive are promising. Since, chicory herb has ability to reduce the levels of some hepatic enzymes such as ALT and AST. In addition, this plant plays a vital role as a natural hepatoprotective agent in reducing many diseases related to liver. Chicory herb or its products exhibit several nutritional benefits by mitigating the lipid peroxidation in serum and organs. Additionally, chicory showed many healthical and pharmacological properties like, hepatoprotective, anti-inflammatory, antioxidant, sedative, immunological, reproductive, cardiovascular, hypolipidemic, anticancer, anti-protozoal, gastro-protective, antidiabetic, analgesic, anthelmintic and antimicrobial. Further studies are required to understand the molecular mechanisms of action underlying the beneficial effects of chicory and find the effective level in animal especially in poultry that would act as liver tonic.

However, further investigations should evaluate the toxicity and safety of chicory herb or its products and oils in

order to new approach for considering their application in healthical purposes and related issues.

### SIGNIFICANCE STATEMENTS

- Chicory herb or its products exhibit several pharmaceutical and nutritional benefits in poultry and animals by mitigating the lipid peroxidation in serum and organs
- *Cichorium intybus* plays an important role as antioxidant, anti-inflammatory, sedative, immunological, productive and reproductive enhancer, cardiovascular, hypolipidemic, anticancer, anti-protozoal, gastro-protective, antidiabetic, analgesic, anthelmintic, antimicrobial, wound healing and bitter tonic without inducing therapeutic adverse effect
- Use of *Cichorium intybus* in livestock nutrition enhances the efficiency of growth, production and health

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