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# The Effect of Jerusalem Artichoke (*Helianthus tuberosus* L.) on Blood Parameters, Liver Enzymes and Intestinal pH in Laying Hens

[1]Gultekin Yildiz, [1]Pinar Sacakli, [3]Tulin Gungor and [2]Hamdi Uysal
[1]Department of Animal Nutrition and Nutritional Diseases,
[2]Department of Biochemistry, Faculty of Veterinary Medicine, University of Ankara, Diskapi, Ankara, Turkey
[3]Department of Animal Nutrition and Nutritional Diseases, Faculty of Veterinary Medicine, University of Kirikkale, Yahsihan, 71451 Kirikkale, Turkey

**Abstract:** A study was conducted to determine the effect of, as a source of inulin, Jerusalem artichoke on intestinal pH, some blood parameters and liver enzymes of laying hens. Control and treatment groups were fed a diet containing 0, 5 and 10% Jerusalem artichoke, respectively. Twenty five weeks old, 45 commercial white laying hens were used in the experiment. In this experiment, inulin was effective on modifying of intestinal characteristics, blood metabolites and liver enzymes in laying hens. Fecal and intestinal pH values were not altered by dietary treatments. Although, unchanged serum cholesterol and albumen content, 5% JA increased glucose ($p<0.001$) and decreased fructose ($p<0.01$), triglyceride ($p<0.01$) and total protein ($p<0.05$) contents when compared with control diet. On the other hand, 10% JA reduced serum glucose as well as fructose levels. Serum SGOT levels was increased ($p<0.01$) by 5% JA addition and ALP levels was decreased ($p<0.05$) by 10% JA.

**Key words:** Jerusalam artichoke, blood parameters, liver enzymes, intestinal pH, laying hen

## INTRODUCTION

Inulin are composed of short chains of fructose molecules found extensively distributed in nature as plant storage carbohydrates. They are present in greater than 36,000 plant species (Niness, 1999; Guarner, 2005).

The use of inulin and fructooligosaccharide (FOS) in the diets of livestock is a relatively recent effort. They are used for their effects on the colonic microflora, gastrointestinal physiology, immune function and bioavailability of minerals, lipid metabolism and gastrointestinal tract health (Roberfroid, 1999). Several studies have been conducted to investigate the effects of inulin or FOS on livestock animals. Fructooligosaccharide supplementation reduces pathogen colonization and contamination in poultry (Patterson and Burkholder, 2003; Verdonk *et al*., 2005). Data from poultry suggest that FOS may be as effective as antibiotic in the control of pathogens and improvement of growth performance (Griggs and Jacob, 2005). Many issues remain unresolved concerning prebiotic oligosaccharides. The composition of the colonic microflora, gastrointestinal health and clinical or performance effects in the animal should be investigated.

This research was carried out to determine the effect of, as a source of inulin, Jerusalem artichoke on intestinal pH, some blood parameters and liver enzymes of laying hens.

## MATERIALS AND METHODS

This study was conducted in University of Ankara, Faculty of Veterinary Medicine, Department of Animal Nutrition and Nutritional Diseases in 2003. Twenty-five-weeks-old, 45 commercial white laying hens were used in the study. They were divided into one control and 2 treatment groups each containing 15 hens. The feeding period lasted 16 weeks. Three birds were housed per 45×45×45 cm wire cage, given feed and water for *ad libitum* intake throughout the experiment and subjected to a photoperiod of 17 h light/day. Its temperature was maintained between 16 and 25°C. The control group was

**Corresponding Author:** Tulin Gungor, Department of Animal Nutrition and Nutritional Diseases, Faculty of Veterinary Medicine, University of Kirikkale, Yahsihan, 71451 Kirikkale, Turkey

Table 1: Ingredient of the experimental rations

| Ingredient | Control group | Treatment groups 5% JA | 10% JA |
|---|---|---|---|
| Barley | 36.5 | 34.3 | 31.3 |
| Corn | 30.0 | 26.0 | 22.0 |
| Soybean meal | 19.0 | 15.5 | 12.5 |
| Poultry meal | 3.2 | 3.0 | 3.0 |
| Vetch | - | 5.0 | 10.0 |
| Jerusalem artichoke (dried)* | - | 5.0 | 10.0 |
| Dicalcium phosphate | 1.6 | 1.5 | 1.5 |
| Limestone | 9.0 | 9.0 | 9.0 |
| Salt | 0.25 | 0.25 | 0.25 |
| Methionine | 0.10 | 0.10 | 0.10 |
| Vitamin-Mineral premix** | 0.35 | 0.35 | 0.35 |
| **Chemical composition** | | | |
| Dry matter | 94.21 | 94.04 | 94.47 |
| Crude protein | 16.90 | 17.00 | 16.63 |
| Ether extract | 3.36 | 3.02 | 3.81 |
| Crude fiber | 3.78 | 3.90 | 3.97 |
| Calcium | 3.40 | 3.75 | 3.65 |
| Phosphorus | 0.63 | 0.60 | 0.65 |
| Metabolizable energy, kcal kg$^{-1}$ | 2654.00 | 2651.00 | 2648.00 |

*Jerusalem artichoke contains 15.80% inulin on a dry matter basis, **Supplied per kilogram of diet: vitamin A, 12.000 IU; vitamin $D_3$, 1.200 IU; vitamin E, 15 mg; vitamin $K_3$, 3 mg; vitamin $B_1$, 3 mg; vitamin $B_2$, 5 mg; vitamin $B_6$, 4 mg; vitamin $B_{12}$, 15 µg; niacin, 18 mg; Ca-D-pantothenate, 6 mg; folic acid, 0.6 mg; vitamin C, 20 mg; colin chloride, 250 mg; manganese, 100 mg; zinc, 60 mg; cobalt, 3 µg; iodine, 1.8 mg; copper, 5 mg; iron, 40 mg

fed a basal diet based on barley, corn, soybean meal and poultry meal. The diets fed to hens of treatment groups contained 5 and 10% Jerusalem Artichoke (JA), respectively (Table 1). Vetch was added to the experimental diets to compensate the possible laxative effect of inulin in JA since tannin in vetch (7.30% tannin) has a constipation effect.

Chemical analyses of feed ingredients and the rations were done by standard AOAC (2000). Metabolizable energy values of rations were calculated according to Titus and Fritz (1971) (Table 1). Tannin content in vetch was determined by Folin-Denis Method from AOAC (2000). Dried at 60°C and grounded, JA was added to the rations. Inulin in rations was determined according to Strepkov Phosphomolybdic-Permanganate Volumetric Method (Winton and Winton, 1947). The modified diphenylamine method described by Little (1949) was used to determine the inulin content in feces. Intestinal tract and fecal pH was measured using microelectrode and pH/ION meter (WTW GmbH, Germany).

Blood samples were centrifuged for 10 min at 4000 rpm after being collected at 5 week intervals, in 28, 33 and 38 weeks of age. Serum glucose, triglyceride, Serum Glutamic Oxaloasetic Transaminase (SGOT), Serum Glutamic Purivic Transaminase (SGPT), Lactate Dehidrogenase (LDH) and Alkaline Phosphatase (ALP) contents were measured using an auto-analyzer (Abot ALCYON-300). Serum fructose level was determined by spectrophotometric method of modified (Davidson and Sackner, 1963).

The data were statistically analyzed by one-way Analysis of Variance (ANOVA) (SPSS Inc., Chicago, IL, USA) followed by Duncan's multiple range test (Duncan, 1955). Mean values were considered significantly different at ($p<0.05$).

## RESULTS AND DISCUSSION

Inulin content of Jerusalem artichoke was found as 15.80% in dry matter basis. Fecal and intestinal pH values were not altered by dietary treatments (Table 2). Although, unchanged serum cholesterol and albumen content, 5% JA increased glucose ($p<0.001$) and decreased fructose ($p<0.01$), triglyceride ($p<0.01$) and total protein ($p<0.05$) when compared with control diet. On the other hand, 10% JA reduced serum glucose as well as fructose levels (Table 3).

The content of SGOT level was increased ($p<0.01$) by 5% JA and unchanged by 10% JA. SGPT and LDH levels remained unchanged by the treatment. ALP level was decreased ($p<0.05$) by 10% JA compared with control and 5% JA diet (Table 4).

In this experiment fecal and intestinal pH were not changed both levels of JA. These results similar to Houdijk *et al.* (1998) investigated lower levels of oligofructose (7.5 and 15 g kg$^{-1}$ diet) in 57 day old pigs. They found that there were no significant differences in fecal pH between the groups. These results differ from those reported in 30-day-old weanling piglets fed 40 g kg$^{-1}$ diet oligofructose, which determined an increase ($p<0.05$) fecal pH compared with the control diet (5.6 in control, 6.2 in oligofructose) (Houdijk *et al.*, 1999). They did not report fecal dry matter percentage like our study. The authors attributed the rise in fecal pH to the complete disappearance of oligofructose prior to the distal colon in addition to a possible increase in proteolytic activity in the colon. In contrast to higher levels (e.g., 40 g kg$^{-1}$), lower levels of inulin may have no effect on fecal pH. This data confirmed the results of Roberfroid (1993), who reported that less than 10% of inulin level has no effect.

In contrast to our expectation, plasma fructose concentration was decreased by inulin supplementation. Furthermore, glucose concentration was increased by 5% JA supplementation but 10% JA as compared to control. Diez *et al.* (1998) determined that there were no differences in plasma glucose and insulin due to 70 g kg$^{-1}$ inulin in dog diets. Indeed, Diez *et al.* (1997) found that 80 g kg$^{-1}$ inulin diet tended ($p>0.05$) to reduce postprandial plasma glucose concentrations as compared to the control. And they reported that at higher levels inulin may play a role in modulation of blood metabolites and be useful in diabetic dog diets. Our result was not confirmed this finding. Because in the present study the

Table 2: Inulin contents of diets and feces, pH values of intestine and faeces (Mean±SEM)

| | | Treatment groups | | |
|---|---|---|---|---|
| | Control group | 5% JA | 10% JA | p-value |
| **Inulin content** | | | | |
| Diet | 0.20±0.01 | 0.40±0.04 | 0.55±0.01 | |
| Faeces | $0.29^{a}$±0.01 | $0.42^{bc}$±0.01 | $0.44^{c}$±0.03 | ** |
| **pH values** | | | | |
| Duodenum | 5.84±0.10 | 6.11±0.10 | 6.01±0.04 | NS |
| Small intestine | 5.67±0.20 | 6.06±0.04 | 5.75±0.08 | NS |
| Caecum | 6.05±0.24 | 5.89±0.14 | 6.14±0.20 | NS |
| Colon | 6.68±0.29 | 6.70±0.14 | 6.04±0.24 | NS |
| Faeces | 6.78±0.10 | 6.24±0.36 | 6.73±0.17 | NS |

$^{abc}$Means bearing different superscripts in a row differ significantly. $^{**}$p<0.01; NS: Non significant

Table 3: Serum glucose, fructose, triglycerides, total cholesterol, total protein and albumen (Mean±SEM)

| | | Treatment groups | | |
|---|---|---|---|---|
| | Control group | 5% JA | 10% JA | p-value |
| Glucose (mg $dL^{-1}$) | $185.69^{b}$±820 | $242.75^{a}$±11.87 | $188.81^{b}$±5.06 | *** |
| Fructose (µg $mL^{-1}$) | $77.92^{a}$±11.44 | $53.90^{ab}$±5.18 | $40.79^{b}$±2.55 | ** |
| Triglyceride (mg $dL^{-1}$) | $1691.58^{a}$±81.39 | $1093.33^{b}$±189.70 | $1476.58^{ab}$±146.85 | ** |
| Total cholesterol (mg $dL^{-1}$) | 188.92±9.86 | 164.75±13.02 | 169.42±13.67 | NS |
| Total protein (g $dL^{-1}$) | $5.72^{a}$±0.15 | $5.17^{b}$±0.17 | $5.36^{ab}$±0.20 | * |
| ALB (g $dL^{-1}$) | 3.61±0.30 | 3.13±0.28 | 3.21±0.29 | NS |

$^{ab}$Means bearing different superscripts in a row differ significantly. $^{*}$p<0.05; $^{**}$p<0.01; $^{***}$p<0.001; NS: Non significant

Table 4: Serum SGOT, SGPT, LDH and ALP values (Mean±SEM)

| | Treatment groups | | | |
|---|---|---|---|---|
| | Control group | 5% JA | 10% JA | p-value |
| SGOT (IU $L^{-1}$) | $197.33^{b}$±10.25 | $248.50^{a}$±13.56 | $209.75^{ab}$±13.60 | ** |
| SGPT (IU $L^{-1}$) | 13.67±0.75 | 12.17±0.93 | 14.00±0.88 | ns |
| LDH (IU $L^{-1}$) | 3039.17±155.75 | 2806.42±372.39 | 3035.33±448.09 | ns |
| ALP (IU $L^{-1}$) | $978.50^{a}$±51.47 | $903.63^{a}$±133.95 | $585.63^{b}$±89.43 | * |

$^{ab}$Means bearing different superscripts in a row differ significantly. $^{*}$p<0.05; $^{**}$p<0.01; ns: Non significant

lower level of inulin (5% JA) increased plasma glucose concentration while the higher level (10% JA) did not change. There is no result the effect of inulin on plasma glucose and fructose concentration in poultry. These discrepancies may be resulted from animal species, diet and inulin concentration.

Serum triglyceride and total protein concentrations were decreased significantly by 5% JA supplementation and numerically by 10% JA as compared to control. On the other hand, cholesterol content tended to decrease (p>0.05) by the treatments when compared with the control diet. Yusrizal and Chen (2003) reported adding inulin or oligofructose at the level of 1% reduced (p<0.05) that serum cholesterol for broilers. They attributed this reduction to the cholesterol assimilation by the Lactobacilli or to the co-precipitation of cholesterol with deconjugated bile salts (Gilliland *et al*., 1985). In another study conducted with dogs, Diez *et al*. (1998) reported that there was no difference in plasma cholesterol and triglyceride due to inulin at the level of 70 g $kg^{-1}$ diet. However, Diez *et al.* (1997) found that after 6 weeks, 80 g $kg^{-1}$ inulin resulted in a reduction (p<0.05) in plasma triglyceride concentrations in dogs.

Serum SGOT levels was increased (p<0.01) by 5% JA addition and ALP levels was decreased (p<0.05) by 10% JA. Inulin may play a role in modulation of liver enzymes but, we are unable to find any reported studies investigated the effect of inulin on liver enzymes. In conclusion, inulin may play a role in modulation of intestinal characteristics, blood metabolites and liver enzymes. Studies should be continued to determine the most effective dose as well as diet and feeding period according to the animal species.

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