Effect of Jerusalem Artichoke (Helianthus tuberosus L.) Supplementation in Diet on Egg Production and Quality Characteristics of Laying Hens

Theerawit Poeikhampha¹, Eakapol Sritiawthai² and Chaiyapoom Bunchasak³

Abstract - Three hundred and twenty-four of 24 weeks hens were used to examine the Jerusalem artichoke (Helianthus tuberosus L.) supplementation as dietary prebiotic in feed on egg production and quality characteristics of laying hens. The dietary treatments were divided into 4 groups and each group consisted of 6 replications with 18 hens. The study were divided into one control (without Jerusalem artichoke) and 2 treatment groups; I) supplementing 50 ppm of dried Jerusalem artichoke in diet and II) supplementing 100 ppm of dried Jerusalem artichoke in diet. At the end of feeding trial (8 weeks), supplementing Jerusalem artichoke in feed did not influence feed intake, final body weight, egg production, egg weight and egg mass (p>0.05), however 100 ppm of dried Jerusalem artichoke significantly increased albumen ratio, yolk:albumen ratio and albumen height of eggs (p<0.05). However, yolk weight ratio, shell weight ratio and shell eggs thickness of eggs did not influence by Jerusalem artichoke. It can be concluded that Jerusalem artichoke useful as dietary prebiotic to accomplish egg quality characteristics of laying hens.

Keyword — Jerusalem artichoke, Prebiotic, Feed Additive, Feed, Egg Quality, Hens

I. INTRODUCTION

JERUSALEM artichoke is a root vegetable from temperate zone. It can serve as fructooligosaccharides which composed of short chains of fructose [1] and considered as a prebiotic [2] which stimulating the growth of bacteria in the lower gut [2],[3] and block the adhesion of pathogenic bacteria in the intestinal mucosa [4] In addition, prebiotics induce the immune response through a direct effect on cell receptors or via change in the intestinal microorganisms [5] Several investigators reported that Jerusalem artichoke improved performance, feed utilization and may improve egg production in poultry [6],[7] Therefore, this research was carried out to determine the effect of Jerusalem artichoke (as a source of prebiotics) on performance and egg quality characteristics in laying hens.

II. MATERIALS AND METHODS

The study was conducted at Animal Research Farm, Department of Animal Science, Faculty of Agriculture, Kasetsart University, Thailand in January to March, 2012. The experimental animals were kept, maintained and treated in adherence to accepted standards for the humane treatment of animals.

A. Animals and Managements

Three hundred and twenty-four of 24 weeks of age laying hens H&N “Brown Nick” were used in the study. During 8 week of feeding trial, three birds were grouped in 40.5 cm x 40 cm (equaling 1,620 cm² total floor space) in wire cage (each hen had approximately 540 cm² of floor space) and raised in evaporative cooling houses and temperature was maintained 26 ± 3 °C. Hen subjected to a photoperiod of 16 h light/day from 05:00 to 21:00 daily. House was cleaned two days interval, while the feces of hens were removed every day. Authors are responsible for obtaining any security clearances.

B. Experimental design and diets

The Completely Randomized Design (CRD) was used as the experimental design. The study was divided into one control and two treatment groups and each group consisted of 6 replications with 18 hens. Three experimental diets were provided as follows; I) basal diet (control), II) basal diet +50 ppm of dried Jerusalem artichoke and III) basal diet +100 ppm of dried Jerusalem artichoke. The basal diets were formulated to provide the same amount of nutrients and met the requirement as commercial recommendation without antimicrobial agent and were analyzed for Proximate Analysis according to the [8] methods. Feed (mash form) and water were provided ad libitum throughout the trial. Body weight and feed intake were recorded two weeks interval.
C. Parameters

The initial body weight of each hens was recorded and at the end of feeding trial (8 weeks) the body weight, body weight gain and feed intake were recorded two weeks interval in order to calculate of body weight gain, average daily feed intake. The morbidity and mortality of hens were observed. Hen-day egg production was recorded daily whereas egg weights were determined 2 weeks interval (4 periods). Egg mass was calculated by multiplying egg weight by hen-day egg production. Feed conversion ratio (FCR) was calculated as gram feed consumption per day per hen divided by gram egg mass per day per hen. During 3 days of the end of each period, 36 eggs from each group were randomly taken in order to determine egg weight, egg component (percentage of egg yolk, egg albumen and eggshell), and albumen high as well as eggshell thickness.

III. STATISTICAL ANALYSIS

All data were statistically analyzed using analysis of variance (ANOVA) of SAS [9] The differences between the means of groups were separated by Duncan’s New Multiple Range Test [10] according to the following model;

\[ Y_{ij} = \mu + A_i + e_{ij} \]

Where; \( Y_{ij} \) is the observed response, \( A_i \) is the effect of diet and \( e_{ij} \) is experimental error; \( e_{ij} \sim \text{NID} (0, \delta^2) \). Statements of statistical significance were based on \( p<0.05 \). All statistical analyses were done in accordance with the method of [11]

IV. RESULTS AND DISCUSSION

A. Performances

Effects of Jerusalem artichoke on production performance of laying hens are shown in Table I. The results indicated that supplementing Jerusalem artichoke 50 and 100 ppm in diet not influenced final body weight and body weight gain and averaged 1.84 kg/hen. In this study, 100 ppm of dried Jerusalem artichoke slightly increased egg production, there was 93.68 % compared to 92.64 % in control group, however the statically difference was not found (\( P>0.05 \)). Feed intake was not affected by Jerusalem artichoke and averaged 114.08 g/hen/day. However, the egg mass was slightly increased and feed conversion ratio was slightly improved by 100 ppm of Jerusalem artichoke supplementation, there were 60.34 and 1.76 compared to 59.00 and 1.80 in control; respectively however the statically differences were not founded (\( P>0.05 \)).

It can be believed that supplementation of 100 ppm of Jerusalem artichoke may improve nutrients utilization (digestion and absorption), since FCR was slightly improved 2.22 % compared to control. Jerusalem artichoke can be a dietary prebiotic due to consists oligosaccharides which commonly use as purified prebiotic [1] In addition, [12] reported that the supplementation of oligofructose to laying hen rations did not influence feed consumption but the hens that received oligofructose produced more eggs than the birds fed a control diet. Therefore, in this study the feed conversion ratio possibly improved by oligofructose addition.

B. Egg quality characteristics

At the end of feeding trial, supplementation 100 ppm Jerusalem artichoke in diet significantly decreased albumen weight ratio although the albumen height was increased (\( p<0.05 \)), the ratio of albumen weight was 51.95 % compared to 55.83 % in control group. The albumen height in the 100 ppm Jerusalem artichoke supplementation was 12.06 mm compared to 10.78 mm in control group. The Yolk : Albumen weight ratio was increased by 100 ppm of dried Jerusalem artichoke, there was 0.65 compared to 0.56 in control group. In this study, Jerusalem artichoke did not influence the yolk weight ratio, shell weight ratio and shell eggs thickness (\( p>0.05 \)) and averaged 32.14 %, 13.77 % and 0.03 mm, respectively. Effects of Jerusalem artichoke on eggs quality of laying hens during 24 – 32 weeks of age are shown in Table II.

### Table I

**EFFECT OF JERUSALEM ARTICHOKE ON PRODUCTION PERFORMANCE OF LAYING HENS DURING 24 – 32 WEEKS OF AGE.**

<table>
<thead>
<tr>
<th>Item</th>
<th>Control group</th>
<th>Jerusalem artichoke 50 ppm</th>
<th>Jerusalem artichoke 100 ppm</th>
<th>SEM</th>
<th>P-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Initial body weight (g)</td>
<td>1.73</td>
<td>1.71</td>
<td>1.70</td>
<td>0.02</td>
<td>0.36</td>
</tr>
<tr>
<td>Final body weight (kg)</td>
<td>1.85</td>
<td>1.83</td>
<td>1.85</td>
<td>0.04</td>
<td>0.60</td>
</tr>
<tr>
<td>Weight gain (g)</td>
<td>0.13</td>
<td>0.12</td>
<td>0.15</td>
<td>0.02</td>
<td>1.00</td>
</tr>
<tr>
<td>Egg production (%)</td>
<td>92.64</td>
<td>93.07</td>
<td>93.68</td>
<td>0.89</td>
<td>0.35</td>
</tr>
<tr>
<td>Feed intake (g/hen/day)</td>
<td>114.40</td>
<td>114.79</td>
<td>113.07</td>
<td>1.57</td>
<td>0.54</td>
</tr>
<tr>
<td>Eggs weight (g)</td>
<td>63.69</td>
<td>63.78</td>
<td>64.41</td>
<td>0.90</td>
<td>0.35</td>
</tr>
<tr>
<td>Eggs mass (kg)</td>
<td>59.00</td>
<td>59.35</td>
<td>60.34</td>
<td>0.38</td>
<td>0.11</td>
</tr>
</tbody>
</table>

**SEM** is Standard Errors of Mean

### Table II

**EFFECT OF JERUSALEM ARTICHOKE ON EGGS QUALITY OF LAYING HENS DURING 24 – 32 WEEKS OF AGE.**

<table>
<thead>
<tr>
<th>Item</th>
<th>Control group</th>
<th>Jerusalem artichoke 50 ppm</th>
<th>Jerusalem artichoke 100 ppm</th>
<th>SEM</th>
<th>P-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Albumen height (mm.)</td>
<td>10.78&lt;sup&gt;a&lt;/sup&gt;</td>
<td>11.64&lt;sup&gt;b&lt;/sup&gt;</td>
<td>12.06&lt;sup&gt;a,b&lt;/sup&gt;</td>
<td>1.19</td>
<td>0.04</td>
</tr>
<tr>
<td>Yolk weight ratio (%)</td>
<td>31.03</td>
<td>31.56</td>
<td>33.57</td>
<td>0.47</td>
<td>0.14</td>
</tr>
<tr>
<td>Albulmen weight ratio (%)</td>
<td>55.83&lt;sup&gt;a&lt;/sup&gt;</td>
<td>54.74&lt;sup&gt;a&lt;/sup&gt;</td>
<td>51.95&lt;sup&gt;b&lt;/sup&gt;</td>
<td>1.19</td>
<td>0.04</td>
</tr>
<tr>
<td>Shell weight ratio (%)</td>
<td>13.14</td>
<td>13.70</td>
<td>14.49</td>
<td>0.09</td>
<td>0.20</td>
</tr>
<tr>
<td>Yolk : Albumen ratio</td>
<td>79.23&lt;sup&gt;b&lt;/sup&gt;</td>
<td>80.96&lt;sup&gt;a&lt;/sup&gt;</td>
<td>83.15&lt;sup&gt;a&lt;/sup&gt;</td>
<td>0.82</td>
<td>0.03</td>
</tr>
<tr>
<td>Shell eggs thickness (mm.)</td>
<td>0.56&lt;sup&gt;b&lt;/sup&gt;</td>
<td>0.58&lt;sup&gt;b&lt;/sup&gt;</td>
<td>0.65&lt;sup&gt;a&lt;/sup&gt;</td>
<td>0.65</td>
<td>0.01</td>
</tr>
</tbody>
</table>

<sup>a</sup> and <sup>b</sup>Means in the same row with different superscripts are different significantly (\( p<0.05 \)) SEM is Standard Errors of Mean
The study of [6] reported that supplementation of Jerusalem artichoke in layer diet tended to increase hen-day production that higher than control group. In addition, the study of [13] reported that supplementation of prebiotic in layer diet tended to improve egg production egg quality and increase yolk : albumen ratio, these results are in agreement with [12] who found that oligosaccharide supplementation in layer diet improved body weight and egg quality.

[14] The albumen height is related with haugh unit which is a parameter of albumen quality and fresh egg [15]. The old eggs decrease albumen height which giving the lower haugh unit [16]. The study of [17] reported that supplementation of oligosaccharide improved the albumen height and haugh unit. This consequence may come from Jerusalem artichoke increased the intestinal mucosa which results in increase the absorption of mineral in gastrointestinal tract that affected to increase absorption of water and mineral to egg [18].

V. CONCLUSION

It was concluded that the supplementation of Jerusalem artichoke had no adverse effect on laying hen performance but had adverse effect on egg quality characteristics. The results indicated that Jerusalem artichoke supplementation may be useful as a prebiotic to accomplish the egg quality in layer hens.

ACKNOWLEDGEMENTS

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