THESIS TITLE: THE USE OF DUCKWEED AS A SUBSTITUTED PROTEIN SOURCE FOR SOYBEAN MEAL IN BROILER AND JAPANESE QUAIL DIETS

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ABSTRACT

A study was conducted to investigate the utilization of dried duckweed (*Lemna* spp.) as a substituted protein source for soybean meal in broiler and Japanese quail rations. The study was subdivided into three experiments. The first experiment was to determine the optimal condition for duckweed production in experimental tanks. The second and the third experiments were to evaluate the effects of substituting duckweed for soybean meal on nutrient digestibility and utilization and on growth performance of broilers and Japanese quail and on laying performance of laying quail, respectively.

In experiment 1, it was observed that duckweed grew rapidly in natural pond if the water in the pond was not disturbed by unfavourable environmental factors such as too intense sunlight or strong wind and the water contains high enough plant nutrients. After removal of duckweed by a half of the pond surface area, it could re-grow and cover the water surface by 3 to 5 days. Under the experimental tank condition, duckweed was grown in tanks containing 300 litres of water with added pre-fermented

liquid fertilizer of layer and swine manure at the rate of 5, 6, 7 and 8 litres per day in a 2X4 factorial arrangement of a Completely Randomized Design (CRD) trial. A 25% of duckweed was harvested on every other day in three 30-day periods. In the first, second and third periods, the manure was pre-fermented at the inclusion rates of 3, 6 and 9 kg in 300 litres of water for 7 days, respectively, before adding the liquid part to the culturing tanks. It was observed that, at the manuring rates of 3 and 6 kg, regardless of sources of manure or rate of fertilizer inclusion, duckweed grew at a similar rate ($P>0.05$) across treatments. However, at the 9 kg manuring rate, the dried duckweed yield linearly increased ($P<0.05$) with the rate of fertilizer inclusion and layer manure gave a significanly higher ($P<0.05$) duckweed yield than did the swine manure. Proximate composition of the cultured duckweed was similar ($P>0.05$) for both sources of manure and for all the rate of fertilizer inclusion. However, the dry matter yield and major nutrient composition of duckweed linearly increased with the rate of manuring from 3 to 9 kg per 300 litres of water in the fermenting tanks. It was thus concluded that duckweed grew more rapidly in the high plant nutrient environment than in the low-nutrient water.

In second experiment, 144 day-old Arbor Acres broiler chicks were randomly assigned, in groups of 12, to receive diets containing duckweed to substitute 0, 10, 20 and 30 % of soybean meal protein during 0 – 21 days and, respectively at 0, 20, 40 and 60 % of soybean meal protein during 21 – 42 days growing periods in a 4-treatment, 3-replication CRD experiment. At the ages of 21 and 42 days, 4 growing and 2 finishing birds from each treatment group were randomly selected for digestibility and metabolism study. The trial was terminated at 42 days of age at which 3 birds in each group were randomly sacrificed for carcass evaluation. It was found that the body weight gain (BWG), feed/gain (F/G) and protein efficiency ratio (PER) of broilers in 10 % duckweed protein substitution at 0 – 21 days and 20 % at 21 – 42 days were comparable ($P>0.05$) to those of the controls while those in the higher substituting levels were linearly poorer ($P<0.05$) than the formers. However, the average feed consumption (FC), metabolizability coefficient of dry matter (MCDM), energy (MCE), protein (MCCP) and crude fiber (MCCF) were similar ($P>0.05$) across treatments. Treatment effect on

carcass dressing percentage was not significantly different (P>0.05); however, carcass grade of highest substituting levels (30 % at 0 – 21 days and 60 % at 21 – 42 days) was significantly lower (P<0.05) than the rests. It was consequently concluded that duckweed protein should not replace soybean meal protein at the levels higher than 10 % (7% of the ration) in starting broiler and 20 % (11% of the ration) in finishing broiler rations.

In experiment 3, three hundred day-old Japanese quail chicks were randomly assigned, in group of 25 birds, to 4 diets substituting duckweed protein for soybean meal protein at the same levels as those done in broiler experiment (experiment 2) for both starting (0 – 21 days) and finishing (21 - 42 days) period. The design of the trial was similar CRD with three replications. Nutrient metabolizability and male bird carcass evaluation were similarly undertaken. In addition, at 42 days of age, ten female quails were randomly selected from each group and assigned to laying diets containing the respective levels of substituting duckweed protein (0, 20, 40 and 60 %) as those in the finishing period. Egg production and egg quality were evaluated in four 28-day laying periods. It was found that BWG of the 10 20 % substituted treatment (T2) was highest but nonsignificantly higher (P>0.05) than the control while those of the higher substituting treatments being linearly decreased (P<0.05) as compared to formers. However, F/G, FC and PER were similar (P>0.05) across treatments. Increase of the substituting levels of duckweed caused significant decrease of carcass dressing percentage but did not change carcass grade. Metabolizability of dry matter, energy, protein or crude fiber were not significantly affected (P>0.05) by duckweed level. Similarly, duckweed levels did not significantly (P>0.05) affect the age at which the quail lay the first egg or the overall laying performance. However, kg feed/kg egg weight was linear increased (P<0.01) as the level of duckweed substitution increased, except only that of 20 % substituting treatment was nonsignificantly poorer than the control. Egg quality in term of egg weight, shell weight, egg mass and egg shell thickness were adversely affected (P<0.05) by increases of the substituting levels. Haugh unit, however, was the same for all treatments. The results suggested that the optimal

substituting levels of duckweed for soybean meal was 10 % of soybean meal protein (8% of the ration) in the starting rations and not over 20 % (11 or 12% of the ration) for finishing and laying quail diets.