

Evaluation and utilisation of mulberry for poultry production in Japan

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Introduction

Mulberry is an indispensable crop for silkworm production. In Japan, sericulture was such an important industry that mulberry was not used for the other purposes, except sericulture. However, recently with the decline of sericultural industry, mulberry has been re-evaluated for other purposes, such as medicinal, fruit and animal production. This paper reviews its evaluation and utilisation for animal production, with special reference to poultry production in Japan.

Fowl raised in mulberry gardens

If domestic and guinea fowls were raised in mulberry gardens, multiple useful effects could be expected: weeding; pest control; extra fertiliser (from manure); high quality and natural egg and/or meat; and feed cost reduction (Watanabe, 1985). From these points in mind, several experiments were carried out in different regional sericulture experiment stations in Japan.

1. Weeding effect

Uchino *et al.* (1988) utilised guinea and domestic fowl (New Hampshire breed) for weed control. A small poultry house was built in the corner of a mulberry garden. Eleven domestic fowl

were put in a mulberry garden of 0.025ha and 10 guinea fowl in one of 0.012ha. Commercial feed was given, 140-150 g/d for each domestic fowl and 70g/d for each guinea fowl. The amount of weeds growing after seven months was measured. Table 1 shows that there were no weeds in the guinea fowl plot, and only few weeds in the plot domestic fowl plot, whereas a large number of weeds, such as *Polygonum longisetum* De Bruyn, *Digitaria adscendens* Henr. (large crab-grass), *Malachium aquaticum* Fries (Mater mouse-ear chickweed), *Senecio vulgaris* L. (common groundsel), *Veronica persica* Poir. (Byzantine speedwell) grew in the control plot. These results indicate that raising guinea and domestic fowl in mulberry gardens control weeds, which otherwise could cause serious damage to mulberry growth. Similar results were obtained in the Oita Prefecture (Urushima *et al.*, 1984, 1987).

Table 1. Amount of weeds growing after seven months fresh matter/m² and percentage relative to control in parenthesis (Uchino *et al.*, 1988)

| Treatment | Amount of weeds | Weed species |
|---------------|-----------------|--|
| Control | 1,064 (100%) | <i>Polygonum longisetum</i> , <i>Digitaria adscendens</i> , <i>Malachium aquaticum</i> , <i>Senecio vulgaris</i> , <i>Veronica persica</i> |
| Domestic fowl | 112 (11%) | <i>Senecio vulgaris</i> , <i>Erigeron philadelphicus</i> |
| Guinea fowl | 0 (0%) | |

2. Fertilising effect of manure

Daily excrement of domestic fowl is about 150g, corresponding to 54.8kg annually. It contains 1.6% of N, 1.7% P and 0.8% K (Maeda *et al.*, 1978). Uchino *et al.* (1988) measured non-organic nitrogen in three places in a mulberry garden. They

found 12-14 times more in the front of the fowl house and 2-5 times more in between rows than in the control garden (Table 2). However, the quantity between stumps was almost the same as in the control garden. This study shows that both guinea and domestic fowl hang around their shelter. Spreading of manure would be necessary to get a uniform fertilising effect

Table 2. Non-organic soil nitrogen, mg/g of dry soil (Uchino *et al.*, 1988)

| Sampling site | Guinea fowl | Domestic fowl | Control |
|-------------------------|-------------|---------------|---------|
| Front of fowl house | 21.3 | 17.8 | - |
| Between mulberry rows | 7.3 | 3.7 | 1.5 |
| Between mulberry stumps | 1.3 | 1.9 | - |

However, a report from the Oita Prefecture indicated that the leaf yield in a mulberry garden which received only a quarter of N fertiliser and has domestic fowls, was the same as the control with 30kg/10area of N (Urushima *et al.*, 1987). Similar results were also obtained in the Saitama Prefecture (Hachisu, 1989). It can be concluded that raising domestic fowls in mulberry garden has a fertiliser effect.

3. Pest control effect

Uchino *et al.* (1988) investigated pest control effect of guinea fowl by dissecting two birds in June and looking at the insects inside their crops. They found that guinea fowls had eaten *Japyyx japonicum* Enderlein, *Aphodium rectus* Motschusky, *Arge similis* Vollenhoven (azalea sawfly) and others. Moreover, daily observation by us confirmed that guinea fowls consumed *Scotinophara lurida* Burmeister (black bug), *Spilarctia imparilis*

Butler mulberry tiger moth), *Apriona japonica* Tomson (mulberry borer), grasshopper, cicada, fry and earthworms. *Apriona japonica* is an insect that causes serious damage to mulberry growth in Japan.

4. The quality of egg and meat produced by guinea fowls and domestic fowls raised in a mulberry garden

Yearly egg production was 170 for a domestic fowl and 90 for a guinea fowl. Guinea fowl do not lay in winter. As shown in Table 3, guinea fowl eggs are smaller compared to domestic fowl, but have thicker eggshell and better preservation. Moreover, guinea fowl eggs are higher in Haugh unit and yolk colour. New Hampshire hens raised in a mulberry garden produced eggs with greater proportion of yolk and higher Haugh unit and yolk colour, compared to eggs from commercial White Leghorn hens. These results demonstrate that eggs produced by guinea and domestic fowl raised in mulberry gardens are superior to those commercially available.

Table 3. Egg quality of guinea and domestic fowl raised in a mulberry garden (Uchino *et al.*, 1988)

| Species | Egg (g) | Yolk (%) | Yolk/white | Shell (%) | Haugh unit | Yolk colour |
|----------------|---------|----------|------------|-----------|------------|-------------|
| Guinea fowl | 39.2 | 31.4 | 0.60 | 16.6 | 83.1 | 13 |
| Domestic fowl: | | | | | | |
| New Hampshire | 60.3 | 29.5 | 0.48 | 9.3 | 67.1 | 12 |
| White Leghorn* | 59.0 | 27.5 | 0.44 | 9.5 | 61.4 | 10 |

*Commercially purchased as a control.

In this experiment, after 23 weeks, domestic fowl, on average, reached 2.0kg and guinea fowl 1.5kg, their normal adult weight, (Uchino *et al.*, 1988).

Guinea fowl meat tastes good and it is relished as a high quality meat in France and Italy, where it represents 30% of poultry meat products (Uchino *et al.*, 1988). On the contrary, in Japan guinea fowl meat is rarely eaten. However, since Japanese food style has changed and there is a growing demand for high-quality meat, guinea fowl meat might be welcomed to the Japanese table.

Mulberry leaf for poultry feeding in Japan

This section reviews the effects of mulberry on poultry production when leaves were fed to domestic fowl

1. Quality of eggs in domestic fowl

Several reports on the utilisation of mulberry leaves for poultry production have been published recently (Tateno *et al.*, 1998, 1999; Suda, 1999; Sudo *et al.*, 2000). When feeds containing 3%, 6% and 9% of mulberry leaf were fed to the domestic fowl (White Leghorn), egg quality (e.g. egg weight and egg production ratio) was almost the same as the control with commercially available feed (Suda, 1999). However, when the feed contained 15% of mulberry leaves, egg quality was significantly lowered (Tateno *et al.*, 1999). However, yolk was more yellow due to the addition of mulberry leaves (Table 4).

Table 4. Egg yolk colour of domestic fowl with mulberry leaves in the feed (Tateno *et al.*, 1999)

| Feed | Yolk colour | | |
|---------------------|-------------|---------------|---------------|
| | Beginning | After 3 weeks | After 7 weeks |
| Control | 8.0 | 8.5* | 9.2* |
| 15% mulberry leaves | 7.8 | 9.6* | 10.1* |

* shows significant difference in 1% level between two food plots.

2. Mulberry leaf effect on health-related compounds in egg yolk and blood serum.

Mulberry leaf in the feed increased vitamin K1 in yolk (Table 5). but did not have an effect on the content of gamma aminobutyric acid (GABA), which plays a role of reducing human blood pressure (Table 5) (Machii, 1990). There was no significant difference in cholesterol content of egg yolk (Table 5). However, lipid peroxide content in yolk significantly decreased after seven weeks of feeding mulberry leaves. It is known that lipid peroxide would be closely related to active oxygen species, which have a role in causing diseases.

Table 5. Health-related compounds in the egg yolk of domestic fowl fed with mulberry leaves (Tateno *et al.*, 1999)

| Compound | Feed | |
|---------------------------|---------|-------------------|
| | Control | 15% mulberry leaf |
| GABA (ppm) | 1 | 1 |
| Vitamin K1 | 1* | 54* |
| Vitamin K2 | 22 | 29 |
| Cholesterol (mg/100mL): | | |
| Before | 15.1 | 15.1 |
| After 3 weeks | 13.9 | 15.6 |
| After 7 weeks | 12.9 | 14.3 |
| Lipid peroxide (nmol/mL): | | |
| Before | 52.6 | 40.8 |
| After 3 weeks | 49.5 | 44.6 |
| After 7 weeks | 57.9* | 41.1* |

*Significant differences between feeds at 1% level.

Table 6. Health-related compounds in blood serum of domestic fowl fed with mulberry leaves (Tateno *et al.*, 1999)

| Compound | Feed | |
|---------------------------|---------|-------------------|
| | Control | 15% mulberry leaf |
| Cholesterol (mg/100mL): | | |
| Before | 130.7 | 146.9 |
| After 3 weeks | 150.4* | 117.7* |
| After 7 weeks | 156.4 | 135.7 |
| Lipid peroxide (nmol/mL): | | |
| Before | 11.6 | 12.1 |
| After 3 weeks | 12.8 | 13.2 |
| After 7 weeks | 13.9 | 11.3 |

* Significant difference between feeds at 1% level.

Moreover, Sudo *et al.* (2000) measured the effect of mulberry on the quantity of beta-carotene contained in egg yolk and blood serum of domestic fowl fed with mulberry leaves only. Beta-carotene content in mulberry leaves was 29mg/100g, which corresponds to level of tea leaf. Beta-carotene in egg yolk and blood serum of domestic fowl fed with mulberry feed was 0.02mg/100g and 0.055microg/100g, respectively, meanwhile in the birds receiving feed without mulberry (control) it was not detected. Beta-carotene has an important role as antioxidant or anti-cancer effect, and when converted to retinol, or vitamin A, has an anti-nyctalopia effect. Retinol concentration in egg yolk and in blood serum was the same in both treatments.

3. Mulberry leaves to reduce odour in manure.

Odours emitted from poultry manure, especially in peri-urban farms, has become a social problem in Japan. Ammonium and hydrogen sulphate are major odour causing compounds in manure. Sudo *et al.* (2000) looked if mulberry leaves had an inhibitory

effect on ammonium and hydrogen sulphate emissions from manure. Ammonium emission was significantly reduced by feeding mulberry, but hydrogen sulphate was not affected (Table 7). Suda (1999) obtained similar results on the inhibitory effect of mulberry leaves on ammonium emission. Thus, mulberry leaves reduce odour in poultry manure.

Table 7. Ammonium and hydrogen sulphate emitted from poultry manure.

| Feed | Odour compound (ppm) | |
|-------------------|----------------------|-------------------|
| | Ammonium | Hydrogen sulphate |
| Control | 2.67* | 9.14 |
| 10% mulberry leaf | 0.29* | 10.89 |

* Significant differences between treatments at 1% level.

Conclusion

It was found that raising domestic and guinea fowl in mulberry gardens benefits mulberry growth thanks to weeding, pest control and fertiliser effects. Egg Haugh unit was also higher. Moreover, when mulberry leaves were given as part of the feed to domestic fowl, it increased vitamin K1 content and decreased odour from manure. Therefore, it is relevant to evaluate and utilise mulberry as a feed for poultry as well as for the sericulture industry.

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