Evaluation of the nutritive value of ensiled and fresh Golden Apple snails (*Pomacea spp)* for growing pigs

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Abbreviations

ADG	Average daily weight gain
CP	Crude protein
DM	Dry matter
EGAS	Ensiled Golden Apple Snail
FGAS	Fresh Golden Apple Snail
FCR	Feed conversion ratio
GAS	Golden Apple Snail
N	Nitrogen
NDF	Neutral Detergent Fibre
NIAH	National Institute of Animal Husbandry

1. Introduction

Village pig and poultry production is usually referred to the as the traditional, backyard or smallholder system. Sources of feed are mainly crop by-products, such as rice bran, broken rice or banana stem. Monogastric animals serve as family savings for short-term needs, such as school fees, books or clothing for children. Animal products provide part of the dietary protein for the rural families (Chantalakhana *et al.* 2002).

In Laos, the majority of pig producers are smallholders, most of whom are located in the rural areas. Depending on the area and scale of production, pigs are important to them as a major source of family income, as a sideline for raising funds for particular purposes, as a savings bank, as a source of protein for the family, and for cultural reasons.
http://www.aciar.gov.au/web.nsp/doc/aciar.5 ND732.

Golden Apple Snails (GAS) *(Pomacea spp)* were first introduced from Thailand into Sikhotabong District of Vientiane Municipality in 1991 and spread to three villages, namely Viengsavanh, Nahai and Phosi. The first damage to lowland rice fields was reported in 1992. A few years later (1994), they were brought from Vietnam to the Northern Provinces of the country, mainly as a source of food.

Since then GAS have spread to 10 of 17 provinces of the country, mainly by way of connecting waterways, such as irrigation canals and rivers, as well as by people. GAS does most damage to young rice seedlings (seedbeds up to 20 days after transplanting), and consequently fields infested with GAS have to be replanted several times in order to replace the missing seedlings.

Presently, GAS is considered a major pest in the rice ecosystems of Laos. However, in Laos damage by GAS is prevented by collecting them in the fields, which has become inefficient in several areas, and due to labor constraints farmers turn to unspecific chemicals for help (e.g. Niclosamide or Baylucide, and Copper sulfate). These chemical products however pollute water and are a serious threat to other aquatic organisms as well as to the health of the people working in the paddy fields. Moreover, the Lao Government has developed several different control techniques focused on integrated apple snail management (e.g. preventing the entrance of the snails to the rice fields, hand picking, transplanting old seedlings, reduction of water levels in the rice fields and using a variety of local experiences (Douangbupha *et al*, 1998).

Utilization of GAS by rice farmers in Laos is mainly for food (85%), animal feed (14%) and liquid bio-fertilizer or compost (only 1%).

Pomacea canaliculata includes 62.0 % (DM basis) crude protein in the flesh of the snail (excluding shell), and 14.9 % dry matter (UAF laboratory, 2004) and it also has high contents of minerals and vitamins (Rice Technology Bulletin, 2001). That GAS is a good source of minerals is indicated by the contents of calcium (35% in the shell) and phosphorus (1.2%) and it is also a good source of energy (13.94 MJ kg^{-1}). Uncooked fresh GAS meal in pig diets can be used at levels of up to 15% (Catalma *et al*., 1991).

By-products of the sugar cane industry in the form of molasses have been used widely as a cereal substitute in livestock feeds (Preston, 1995). This product has been shown to be promising for fattening pigs (Bui Hong Van and Le Thi Men, 1994) and has been used to make silage from high protein by-products such as shrimp waste (Ngoan *et al*, 2000a).

2. Objectives

- To determine the optimum proportion of a mixture of molasses and rice bran to GAS for ensiling the snails.
- To compare ensiled and non-ensiled golden apple snail in terms of digestibility and growth performance of pigs.

3. General discussion

3.1. Feed resources for pigs production in Laos

Pig diets in Laos are usually based on rice bran, maize, cassava, alcohol production waste, edible grasses or weeds and waste food. Commercial pig feeds are generally only used in urban and peri-urban areas of Vientiane City. Commercial pig feed is expensive by local standards and is therefore only used in the larger production systems. Improved feeds, such as cassava, maize and rice bran, are used by some farmers but availability depends on production, and processing time is a problem **(**Vongthilath and Blacksell, 1999; Phonekhampheng *et al*, 2003).

Recently, several studies have been carried out on improving diets for fattening pigs by using locally available feed resources as protein supplements. For example: A study on the potential use of *Stylosanthes guianensis CIAT 184* as a protein source for indigenous pigs in the upland farming systems in Laos by Keoboualapheth and Mikled (2003). Also Koutsavang and Ogle (2005) evaluated Stylosanthes and dried cassava leaves as protein sources for growing pigs, and an experiment was carried out on the effect of roughage level on the growth performance of crossbred pigs (Douangphasy *et al*, 2003).

Making silage and using locally available, low-cost feed resources for pig production in Laos is therefore important. The abundant fishery products and Golden Apple Snails (GAS) *(Pomacea spp)* can contribute large amounts of protein to pig production in Laos. The life cycle of GAS is around 60 days and it has a reproductive life of 60 days – 3 years. A female lays about 1000-1200 eggs in a month (Sebastian, 2001), which implies a very rapid increase in numbers.

Farmers who live near rice fields collect GAS from the fields, then break open the shell and feed the flesh to their finishing pig directly. However, farmers prefer not to feed GAS to young pigs due to the presence of bits of the shell, which would damage the mouth and stomach.

3.2. Potential of Golden Apple Snail as a protein resource for monogastric animal production in Laos and other tropical countries

GAS is available year round, and in May during the dry season the number of males, at 87% of the total, is higher than females. When the rains start, the number of males decreases and is lowest (33 %) in August. During the rainy season (July-September) the number of female snails is high because this is the reproductive period (Banpavichit *et al*, 1994).

The Golden Apple Snail (*Pomacea canaliculata*) is a high-protein non-conventional feed resource that is abundant in farmlands in SE Asia (FAO, 1997) Today Golden Apple Snails are found in ten provinces of Laos, and cause serious damage to rice seedlings and aquatics plants in the rice ecosystem. Farmers tried to control them by using pesticides, but this will cause more environmental pollution in the future. Therefore, the Lao government has encouraged farmers to control the snail by natural methods and encouraged the use of the snail as a fertilizer and feed for livestock (Douangbupha *et al*, 1998). Most farmers in Laos use the GAS for duck production, because they are able to crush the shell with their bills.

3.2.1. Nutrient content of Golden Apple Snail (GAS)

The GAS components of shell and flesh are 319 g/kg and 360 g/kg (fresh basis), respectively. The chemical composition of fresh Golden Apple Snail (FGAS), includes dry matter, 181 g/kg (DM), 149 /kg DM ash, and the crude protein (CP) content of 621 g/kg DM is similar to fish meal, that in Laos contains 450-650 g/kg DM of CP (Gold Coin Feed factory, 2000). The CP content of FGAS in the Philippines (319 g/kg DM, with some shells) (FAO, 1997) is lower than the CP content of fish meal and FGAS in Laos. Growing pigs require essential amino acids for their muscle tissue development, especially lysine and methionine, which are the most limiting amino acids in diets for growing pigs and that can be supplied by feedstuffs from animal tissue such as fish meal. However, in Laos, fish meal has to be imported from Thailand and is very expensive. FGAS is a good alternative protein resource in terms of both quantity and quality for fattening pigs, because of the high crude protein in

the flesh of GAS, and the good balance of amino acids for growing pigs, as shown in Table 1. The content of the two main limiting amino acids, lysine and methionine, is meet to the requirement for growing pigs (Table 2).

Table 1. Amino acid content of fresh Golden Apple Snail flesh (% of DM)

Amino acid	% of DM
Histidine	5.08
Threonine	9.00
Arginine	13.82
Valine	9.23
Methionine	3.48
Phenylalanine	7.10
Isoleucine	8.19
Leucine	15.20
Lysine	4.18

Table 2. Requirement for crude protein (CP), lysine and methionine + cystine (% of diet DM) for growing F1 pigs (NIAH, 1995)

	Live weight of pigs		
	15-30 kg	30-50 kg	>50 kg
CP	16.0	14.5	12.0
Lysine	0.90	0.70	0.60
Methionine + Cystine	0.45	0.35	0.30

3.3. Ensiling fresh Golden Apple Snail flesh

3.3.1. Principle of ensiling

Currently, GAS is not really considered to be a human food resource as it is not well liked. It has rapidly spread and become pest in the rice fields of Laos, and other Asian countries. So ways of the snail are being investigated, but a problem is the seasonal availability. Another constraint has been the investment cost in small-scale production. However, ensilage is a simple and low cost option, which can preserve feeds that are seasonally abundant for later feeding during periods of feed shortage. Also ensiling can also render some previously unpalatable products useful to livestock by changing the chemical nature of the feed (Chedly and Lee, 1998). The term fermentation is a process to describe the breakdown of carbohydrate materials under anaerobic conditions (Potter, 1978). Ensiling is the process of controlled fermentation of raw materials of high moisture content by the activities of microorganisms in anaerobic conditions, which encourages the growth of lactic acid bacteria, or by using chemical additives (McDonald *et al*., 2002).

3.3.2. Additives

Silage additives can be classified into two main types (McDonald *et al*., 1995): fermentation stimulants, such as sugar-rich materials, inoculants and enzymes, which encourage the development of

lactic acid bacteria, and fermentation inhibitors, such as acids and formalin, which partially inhibit microbial growth.

The silage additive is important for supporting microbial growth during the fermentation period. Molasses is a good, cheap additive with a high water- soluble carbohydrate content of about 700 g/kg dry matter (DM) (MacDonald, *et al*., 2002). The main function of a silage additive is to increase the nutritional value or improve the fermentation (Ohio State University Extension, 2001)

Raw materials low in lactic acid bacteria content generally benefit from suitable inoculants (Martin *et al.*, 1995). Protein-rich feeds with low energy contents, such as fish waste, poultry litter and also FGAS should not be ensiled alone. However, this type of feed can be successfully ensiled when mixed with one or several energy-rich products, such as rice bran and molasses (Chedly *et al.,* 1998).

3.3.3. Ensiled Golden Apple Snail

Making silage of FGAS is a way of processing the product, which is a low cost investment and is also a simple method for small-scale production. Because of the chemical composition of the flesh of Golden Apple Snail (FGAS), which has a low DM and high CP content, it is not easy to make silage that will be preserved for several months. Therefore it requires additives for supporting microorganism growth during the fermentation process. Carbohydrate or energy rich sources such as rice bran and molasses are high in water-soluble carbohydrates which encourage microbial activity during fermentation. In Paper 1 two different ratios of an additive mixture of rice bran and molasses to FGAS were shown to be suitable for fermentation. Good FGAS silage can be critically evaluated according to fermentation characteristics such as pH, NH_3 content, smell, color and also changes in chemical composition during ensiling.

3.4. Effect of different ratios of Golden Apple Snail to an additive mixture of rice bran and molasses on nutrients of the silage

The chemical composition data of FGAS show it to have a high moisture and protein content, which means it is difficult to make silage from. It also has a low energy content and therefore should be mixed with easily fermentable, energy-rich products, such as molasses or a mixture of molasses and rice bran (Chedly *et al*, 1998).

Three different proportions of an additive mixture of rice bran and molasses (9:1) to fresh snails were tested: 1:1, 1:2 and 1:3 on a fresh basis, and designated MRS1, MRS2 and MRS3, respectively. In Paper 1, initially the MRS1 silage had a brown color that was somewhat darker for MRS2 and MRS3. After 7 days the color for all treatments changed to a yellow-brown and each had a good smell. The color did not change further, but treatments MRS2 and MRS3 had a dark surface. Dry matter (DM) and organic matter (OM) contents decreased with ensiling time in all treatments. Crude protein (CP) remained constant in MRS1, and increased with ensiling time in MRS2 and MRS3. The concentration of ammonia-N increased with time of ensiling on all treatments. pH values fell to below 5.0 in the first 7 days of ensiling on all treatments and then remained constant, except for treatment MRS3, in which pH increased to 5.34 at 14 days and then remained constant up to 168 days. DM and CP contents were different among treatments at all sampling times during ensiling, due to the different ratios of FGAS to the additive mixture. pH values were not different among treatments at 0 and 7 days, but thereafter were higher in MRS3 than in the other two silages

3.5. Effect of including flesh fresh and ensiled golden apple snail in diets on nutrient digestibility in growing pigs

The digestibility of a food is closely related to its chemical composition, the composition of other foods consumed with it and also the preparation of food influences nutrient digestibility (McDonald *et al*, 2002). In Paper II, it is shown that when fresh (FGAS) and ensiled Golden Apple Snail (EGAS) replaced 30% DM of a basal diet the DM and OM digestibility in the basal diet was higher than in the FGAS and EGAS diets. The molasses in the silage additive mixture would have been highly digested (McDonald *et al*., 2002), but this would have been cancelled out by the low digestibility of the rice

bran, which in Laos usually contains a high proportion of hulls. However, crude protein digestibility had the same value among diets and was similar to results reported by Phiny *et al.* (2003) for fresh water fish mixed with rice bran (65 % fresh fish and 30 % rice bran) and different ratios of sugar palm syrup. However, the apparent digestibility of CP of ensiled shrimp by-product was reported to be 750 g/kg DM, which was lower than in EGAS, probably due to the high chitin content of shrimp by-product (Ngoan *et al.*, 2000b).

The apparent DM digestibility of EGAS was slightly higher than that of FGAS, probably because of the presence of highly digestible molasses in the additive mixture. Apparent CP digestibility was high and there was no difference between the ensiled and fresh GAS. Other authors have also found that the N digestibility in fish silage is high (FAO, 2005; Green *et al*., 1982; Taylor, 1976) and that processing (drying) did not affect nutrient digestibility (FAO, 2005).

3.6. Effect of including fresh and ensiled Golden Apple Snail in the diet on the performance of growing pigs

The protein content and quality of fresh Golden Apple Snail (FGAS) are two important factors that require attention when GAS is used as protein source for growing fattening pigs under farm conditions. GAS is an ideal protein source for livestock because of the high content of the essential amino acids that animals require for their growth, especially lysine and methionine (McDonald *et al*, 2002). It can also be fed to pigs in either fresh or ensiled form without any negative effect on growth performance in growing pigs (Paper III). In Paper III, it was shown that GAS can replace 100 % of the fish meal in either fresh or ensiled form in diets of growing pigs, resulting in lower daily feed intake and efficiency of feed conversion, but similar daily weight gain when compared to the control fish meal diet. Similar results were reported by Lien *et al.* (1994) in a trial in which pigs were fed a silage of shrimp heads, animal blood and molasses as replacement for fish meal in a cereal-based diet at levels of up to 5 % of diet DM. Ngoan *et al* (2000c) also found that when ensiled shrimp by-product replaced 50 % of the fish meal in pig diets this did not affect performance, except for lower feed conversion ratios. However, in our study the back fat thickness was lower when both FGAS and EGAS replaced fish meal.

3.7. Economic efficiency of including fresh and ensiled Golden Apple Snail in diets for growing pigs

The protein quality of FGAS is similar to other animal protein sources, especially fish meal, which is expensive, and is imported from Thailand. Ensiling the flesh of the Golden Apple Snail is a simple and low cost process, and gives lower feed costs compared to FGAS because the GAS were purchased from local farmers, and included labor costs for removing shells and chopping. Labors costs were estimated to be about 27 % of the total diet cost. In the lowland rice production system of Laos, the GAS is considered to be a pest and has no economic value. Collecting and processing GAS for feeding to pigs gave higher economic benefits from pig production, would also result in higher rice yields and reduced costs for pesticides.

4. Conclusions

- Fresh Golden Apple Snail (FGAS) can be preserved by ensiling with an additive mixture of rice bran and molasses. The silage with a ratio of 1:2 (additive mixture of rice bran and molasses [9:1] to FGAS) resulted in a good quality product that could be stored for at least 6 months.
- Fresh and ensiled GAS had similar nutrient digestibility values for fattening pigs
- The use of fresh and ensiled GAS in F1 fattening pig diets, as complete replacement for fish meal, can be recommended under small-farm conditions. Although feed intake decreased, daily gain and feed conversion efficiency and economical efficiency increased.
- Using GAS in diets for pigs also has the advantage of removing the pest from the rice fields, which reduces the need for pesticides and increases rice yields.

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