Valorization of Palm Kernel Meal via Bioconversion: Indonesia's initiative to address aquafeeds shortage

Saurin Hem, Melta Rini, Chumaidi, Maskur, Ahmad Hadadi, Supriyadi, Ediwarman, Michel Larue and Laurent Pouyaud

This article outlines the initiative of Indonesia to convert "waste to wealth" through the natural process of bioconversion to produce aquafeeds from palm kernel meal for the country's rural aquaculture. This is based on a poster paper presented by the authors during the International Conference on Oil Palm and Environment (ICOPE), 15-16 November 2007, Bali, Indonesia.

Indonesia's demand for aqua feeds, specifically the commercial fish pellets has increased due to the expansion of its rural aquaculture sub-sector. However, the price of aquafeeds or commercial pellets for aquaculture nowadays has become unaffordable to many small-scale fish farmers due to the ever increasing price of fishmeal, which the country imports from Peru, Chile, and other South American countries. The price of fishmeal also continues to soar not only because of its high demand worldwide but also because of the stagnation of fish production from the natural resource. Indonesia spends about USD 200 M per year for the imported fishmeal for its aquaculture industry. If such situation continues, the development of the country's aquaculture will be hampered. Fearing further decline of fish production from aquaculture while boosting the rural economic sector to address the country's food security concern, Indonesia has tried various alternatives to produce aquafeeds using locally available ingredients.

Many research efforts related to the production of alternatives to fish meal have already progressed in many countries not only in Asia but also in the Americas. The use of insects as source of protein in fish diets has already been successfully tried. In China for example, the nutritive value of insects as feeds for cultured fish has already been recognized where studies have demonstrated that insect-based diets are cheaper alternatives to fish meal. The most popular insect used in this particular case is the Black Soldier (BS) fly, *Hermetia illucens* (Stratiomyidae, Diptera).

BS fly is a non-pest tropical and warm-temperate insect that has been found useful for managing large concentrations of bio-solids as well as other by-products and wastes. A cosmopolitan species that is widespread in Indonesia, the larvae (maggots) of the BS fly at first sight might look like those of the blue fly or house fly. However, there is a huge difference since the latter species are true pests, while the BS fly is rather a "flower species" and not a pest at all. Its

usefulness as source of protein for fish culture has been recognized since the 1950s by many researchers from the USA. Many research studies on the larvae of *Hermetia illucens* have also been conducted in some Southeast Asian countries and expanded in Indonesia, after a huge population of the BS fly was spotted in Sukabumi and Depok Provinces of West Java.

Bioconversion of Palm Kernel Meal

Indonesia is the second world producer of palm oil after Malaysia. Aside from palm oil, the industry yields huge amounts of palm kernel meal (PKM or Bungkil). PKM is a by-product after palm oil has been extracted from the African Oil Palm (*Elaeis guineensis*), which was introduced in Sumatra in the early 1900s. It was reported that in 2006, Indonesia produced about 2 million tons of PKM of which only one-half was exported. Since so much PKM is available and sometimes considered as wastes, the country's fisheries sector is conducting a bioconversion research program which aims to address two-tailed concerns: reducing the need for imported fishmeal for its aquaculture industry; and value-adding a local resource, the locally-produced PKM. However, proteins and fats locked in the PKM can not be used directly by fishes (Hem, et. al. 2008), but since the enzyme from maggots, e.g. larvae of

H. illucens could be used as fish feeds, this leads to maggot biomass production through bioconversion.

Bioconversion is a natural process which consists of the transfer of nutrients via biodegradation using the larvae of an insect. It has been considered the cleanest, most efficient and most economical way to recycle waste products. Since bioconversion does not require electricity, chemicals not even water, it does not produce any greenhouse gases, and the process does not require any imported technology. The agent chosen for the bioconversion process of the PKM in this Indonesian initiative is the BS fly.

As previously reported, BS fly has been found effective in reducing the mass of solid wastes. Fish feeding experiments and analysis also indicated that dried BS fly prepupae grown in selected solid wastes have the nutritive value required in cultured fishes. Since BS fly is capable of converting residual protein in solid wastes and other nutrients into biomass, it could produce high quality protein feedstuff. Some studies have also proved that pollution reduction could be one of the returns for good bioconversion management.

While research studies conducted in some countries made use of fungus and insects such as silkworm, housefly, etc. for the bioconversion of PKM to produce fish feeds, a key step in the bioconversion process in Indonesia is the elucidation of the life cycle of the BS fly, *Hermetia illucens*, with particular emphasis on its reproductive biology (breeding behavior, reproductive cycles, etc.). As demonstrated in previously reported research works, the resulting biomass of larvae (42% crude protein and 30% crude fat) acts as a viable alternative source of animal protein for sustaining the development of aquaculture.

Recently developed in Indonesia, the PKM bioconversion program aims to promote an in-depth understanding of the bioconversion process and at simplifying the production process of the maggot feeds or "magfeeds" so as to promote its implementation in the rural context. The initial application in Indonesia of the bioconversion technology at a small-scale level (1 mt of magfeeds per month) has been validated in 2006-2007 at its Aquaculture Development Center (Balai Budidaya Air Tawar or BBAT) in Jambi Province.

Way Forward

The country's pilot PKM bioconversion project planned in 2008 will aim to produce a maggot biomass of 10-15 mt/month with direct application to aquaculture. The bioconversion of PKM into "magfeeds", a natural process dubbed "from waste to wealth", is a promising research topic. With the objectives of addressing local needs with local resources, it could also contribute to fishmeal replacement in a broader, worldwide context, since the bioconversion agent is locally available. Furthermore, "the capacity of a country to produce local resources that substitute imported products represents a strong criterion of sustained economic growth."

References

Hem, Saurin, Sékou Toure, Cé Sagbla and Marc Legendre. 2008. Bioconversion of palm kernel meal for aquaculture: Experiences from the forest region (Republic of Guinea). African Journal of Biotechnology, Vol. 7 (8). pp. 1192-1198.

Ng, W.K. The potential use of palm kernel meal in aquaculture feeds. In: Proc. Queensland Poult, Sci. Symp. Australia. Vol. 11, 1-15

Ogunji, J.O., Kloas, W., Wirth, M., Schulz, C., Rennert, B. 2006. Housefly Maggot Meal (Magmeal): An Emerging Substitute of Fishmeal in Tilapia Diets. Presented at the Conference on International Agricultural Research for Development, Deutscher Trapentag 2006, Stuutgart-Hohenheim, Germany, 11-13 October 2006

Sheppard, C.D., Tomberlin, J.K., Joyce, J.A., Kiser, B.C., Summer, S.M. 2002. Rearing Methods for the Black Soldier Fly (Diptera: Stratiomyidae). Journal of Medical Entomology, Vo. 39, No. 4, July 2002. pp. 695-698

Sundu, B. and Dingle, J. Use of enzymes to improve the nutritional value of palm kernel meal and copra meal. In: Proc. Queensland Poult, Sci. Symp. Australia. Vol. 11, 1-15

About the Authors

Saurin Hem, Michel Larue, and Laurent Pouyaud are with the Institut de Recherche por le Development (IRD), Wisma Anugraha, Jalan Taman Kemang, Jakarta Selatan 12730, Indonesia

Melta Rini and Chumadi are with Loka Riset Budidaya Ikan Hias Air Tawar Depok, Jl. Perikanan No. 13, Pancoran Mas-Depok 16432, Jawa Barat, Indonesia

Maskur and Ahmad Hadadi are with Balai Besar Pengembangan Budidaya Air Tawar Sukabumi, Jl. Selabintana No. 37 Sukabumi 43114, Jawa Barat, Indonesia

Supriyadi and Ediwarman are with Balai Budidaya Air Tawar Jambi, Jl. Jenderal Sudirman No. 16, The Hok, Jambi, Indonesia