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# MrFeed

## A fermentation product as a feed ingredient for aquaculture

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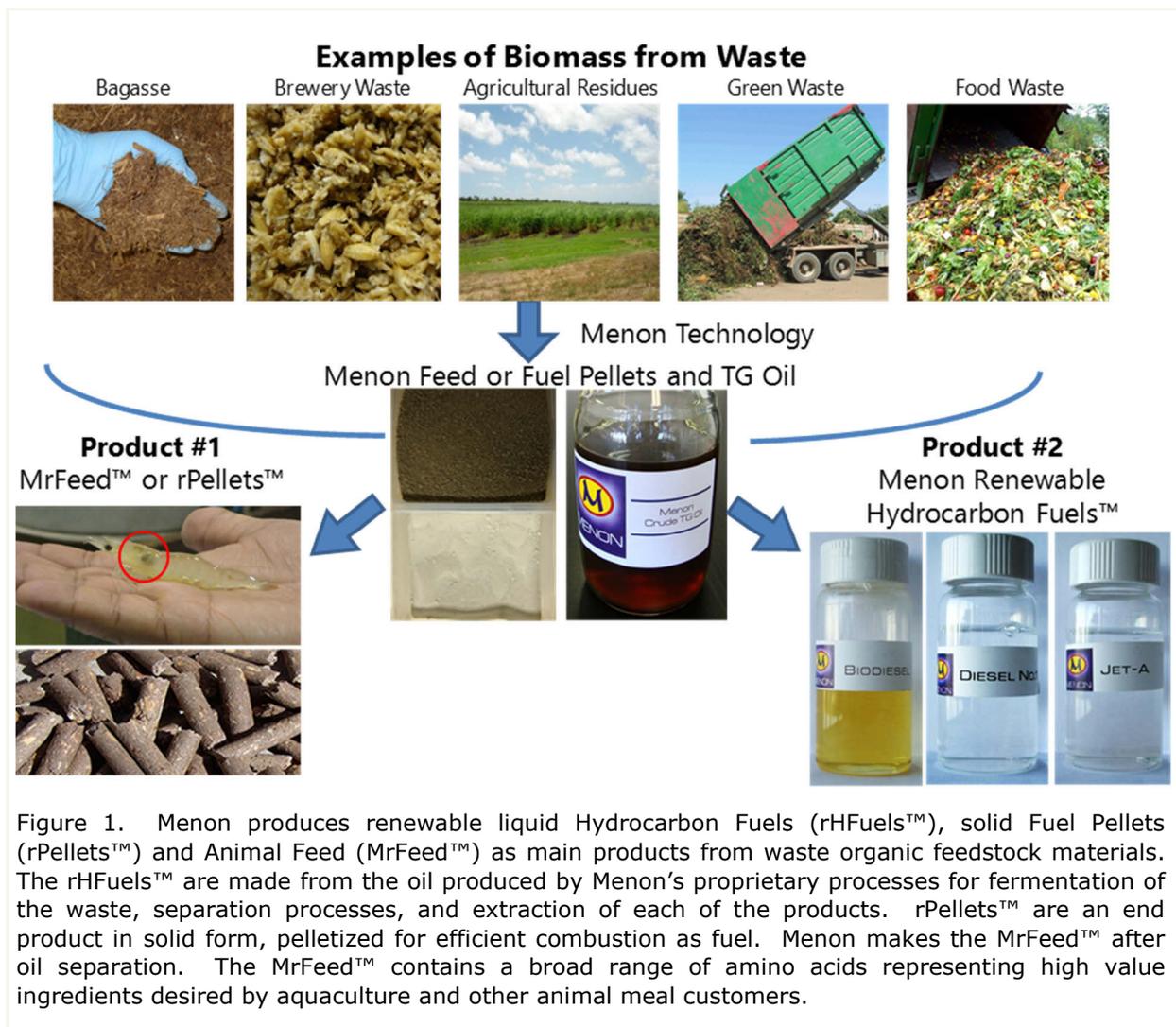
Menon International, Inc. is engaged in designing, building, owning and operating proprietary fermentation and production facilities for the economic conversion of low value organic waste into high value renewable feed, fuels, energy and water. The Menon process results in products consisting of: (a) a high-value animal feed ingredient to make Menon Renewable Feed (MrFeed™) that can be sold to customers in the aquaculture and animal feed industries; (b) triglyceride oil (TG Oil) from waste that can be converted into complete, drop-in replacement Renewable Hydrocarbon Fuels (rHFuels™) fully compatible with existing biodiesel and jet engines; (c) high energy, low sulfur solid renewable fuel pellets (rPellets™) that can replace the use of coal for energy; and (d) water recovered from the process can be converted into potable water and provided back to the producer of the waste.

As illustrated in Figure 1, Menon's core technology provides a unique pathway that converts agricultural or other organic wastes into high value MrFeed for animal feed, triglycerides (TG Oil) for renewable liquid fuels or rPellets for energy. The TG Oil is converted by a third party or optionally with fuel conversion infrastructure by Menon into complete, drop-in replacement liquid hydrocarbon fuels fully compatible with existing diesel engines.

After extraction of the TG Oil, the remaining material can be channeled into MrFeed, a validated high-value animal feed ingredient; or rPellets, a high-energy solid fuel pellet capable of displacing coal. Thus, Menon's technology and process offers an economical method for conversion of agricultural or other organic waste residues – non-food lignocellulosic materials – into both fuel and feed. Combining Menon's technology and processes with sustainable waste handling practices can ensure a supportable and economically viable fuel industry that also reduces greenhouse gas (GHG) emissions while providing new jobs to the community.

### Menon MrFeed

Menon's MrFeed is a superior protein meal additive for animal and aquaculture feed. Menon has concluded feed trials on Pacific white shrimp, *Litopenaeus vannamei*, in which test feed incorporating Menon's MrFeed significantly outperformed a premium commercial feed in shrimp survivability. MrFeed trials have also been completed with Rainbow trout, with results indicating a high fish survival rate and feed palatability value. Blended with standard commercial feed, MrFeed provides a balanced diet for animals. The feed ingredient has been qualified by independent test laboratories and large animal feed corporations for large fish such as Rainbow trout and yellowtail, equine, cattle, swine, poultry and other aquaculture applications.



## MrFeed Properties

The Menon team, through collaboration with several independent US and international government and private laboratories, has characterized MrFeed for animal feed ingredient applications (Figure 2).

**Crude Protein.** The Crude Protein value indicates the quality, value and potential application of the feed product. Proteins are essential components of aquatic and land animal diets, and are the basic structures used to make up all tissue including bone, skin, hair and organs. Menon's MrFeed contains crude protein that is superior to Brewers or Distillers grains and corn gluten feed, which are commonly used cattle feeds. For example, feeds such as grains contain up to 13% crude protein. For cattle, protein is critical for milk production, reproductive performance and weight gain. Protein requirement for cattle varies based on the stage of production, size of the animal and expected performance; however in general cattle need to consume feed that contains 6-11% crude protein by dry weight. For poultry, feed should contain 18-23% crude protein. Fish consume protein to obtain amino acids and use the excess amino acids as an energy source. Protein is digested to release free amino acids, which are absorbed from the intestinal tract

and used by various tissues to synthesize new protein. Inadequate protein in the diet can result in reduction of growth and loss of weight. Most fish require feed containing 30-50% protein. Menon process can be optimized to get the protein range between 25-60% depending on end users requirement.

**Amino Acids.** Amino acids are the building blocks of structural and metabolic proteins for all living things. There are 10 amino acids that are considered indispensable for most animals: arginine, histidine, isoleucine, leucine, lysine, methionine, phenylalanine, threonine, tryptophan and valine. These amino acids cannot be synthesized by the organism and must be provided by the diet. MrFeed provides all of these essential amino acids to animal diets (Figure 3).

MrFeed provides an array of amino acids suitable for satisfying the nutritional requirements of a wide variety of animals including lysine and methionine, known to be rate limiting amino acids in standard poultry

Mass Balance	
Parameter	Value (%)
Moisture (KF)	9.0
Protein	41.0
Fat	5.0
Fiber	6.7
Carbohydrates	24.3
Ash	4.0
Pre- and probiotics	5.0
Free sugars	5.0
<b>Total</b>	<b>100</b>

Figure 2. Specifications of MrFeed.

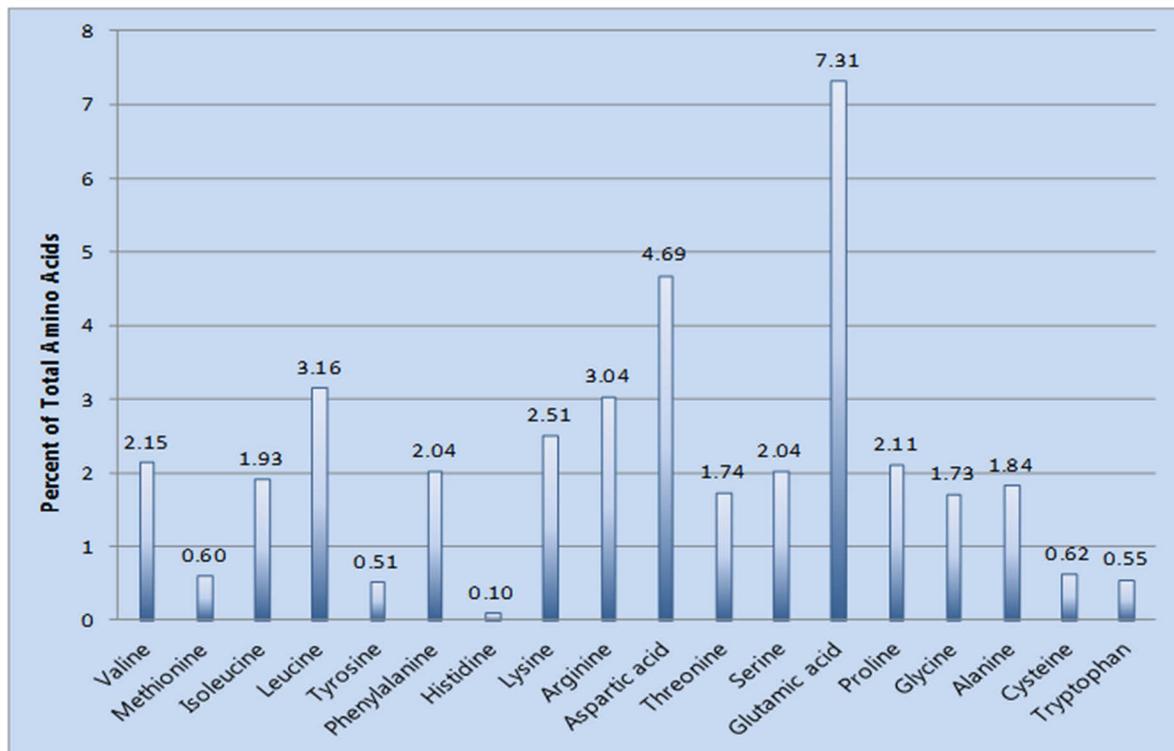


Figure 3. Amino acid profile of MrFeed.

and cattle feeds. High abundance of glutamic acid, among the recognized chemical attractants for shrimp, indicates a high palatability value for MrFeed as a food source for aquatic animals.

**Vitamins and Minerals.** MrFeed™ contains vitamins A, B, E and K, nutrients that are required in fish and animal diets (Figure 4). These vitamins are essential for normal health and life functions including growth, development, maintenance and reproduction.

**Other features:**

- Phosphorus is present in the form of lecithin, which improves pelletization and digestibility of Menon MrFeed. Lecithin is a unique feed ingredient in that it functions as both an emulsifier and dispersing agent, giving MrFeed a stable composition for both land and aquatic applications.
- The triglycerides extracted from the MrFeed can be provided either as a separate ingredient or unextracted from the feed biomass. The triglyceride profile includes C18 and other components considered highly valuable as fish oil ingredient.
- The MrFeed density allows proper pelletization and dispersal through the water medium. The pellet sinks slowly to the bottom allowing the fish to access the feed.

## Experimental Studies

### Shrimp studies

Shrimp fed the experimental diets survived at least as well as those fed the commercial diets, and shrimp fed the experimental diets incorporating MrFeed at 9% or 12% exhibited increased survival relative to shrimp fed the experimental diets incorporating 0% or 6% of the MrFeed. It is possible that some component of MrFeed has a stimulatory effect on the immune system of the shrimp, rendering them more able to fend off pathogens. A preliminary analysis of the carbohydrate fractions of MrFeed revealed high levels of glucans. The immune system of Penaeid shrimp is known to be stimulated by glucans, especially the  $\beta$ -1,3-glucan. A preliminary disease challenge conducted in conjunction with the feeding trial in this study using a pathogenic strain of *Vibrio harveyi* showed that the survival of shrimp fed diets containing MrFeed™ was numerically enhanced compared to that of shrimp fed the control diet. Patterns of total hemocyte and granulocyte counts in the hemolymph of the shrimp were similar to the typical patterns<sup>4</sup> of the immune response in shrimp whose immune system is activated with dietary  $\beta$ -1,3-glucan. Proper, controlled studies are required to confirm this effect.

### Yellowtail fish studies

Survival and food conversion ratio for yellowtail fish fed diets containing varied levels of MrFeed ingredient. Results indicate that MrFeed™ is a suitable ingredient in yellowtail

Minerals/Vitamins	
Calcium	1700 ppm
Copper	13.0 ppm
Iron	210 ppm
Magnesium	2600 ppm
Manganese	29.1 ppm
Phosphorous	6000 ppm
Potassium	14800 ppm
Sodium	500 ppm
Sulfur	3900 ppm
Zinc	46.8 ppm
Vitamin A	70 IU/100 g
Vitamin B1	1.75 mg/kg
Vitamin B2	4.3 mg/kg
Vitamin B6	3.95 mg/kg
Vitamin B12	0.06 mg/kg
Vitamin E	137 IU/kg
Vitamin K	1.8 mg/kg

Figure 4. Specifications of MrFeed

diets at an inclusion level of up to 25%, the highest level tested in the trial. Though Diet 1 showed significantly faster growth rate and lower FCR initially, by the end of the trial it was found that there was no statistical difference in final weight and weight gain between the diets. The reduced initial growth rate for the MrFeed diets could be attributed to its higher fiber content, however its high palatability value allowed for increased performance over the length of the trial. In conclusion, the MrFeed ingredient is a suitable ingredient at inclusion levels of up to 25% in the diets of yellowtail amberjack fish, exhibiting equivalent performance to the standard commercial ingredient, sardine meal.

References

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<sup>2</sup>He, H., Addison, L.L., & Liu, R. (1992) Evaluation of dietary essentiality of fat-soluble vitamins, A, D, E and K for penaeid shrimp (*Penaeus vannamei*). *Aquaculture*, 103: 177-185.

<sup>3</sup>Vargas-Albores F, Yepiz-Plascencia G (2000) Beta glucan binding protein and its role in shrimp immune response. *Aquaculture* 191:13-21.

<sup>4</sup>Chang C, Su M, Chen H et al (2003) Dietary  $\beta$ -1,3-glucan effectively improves immunity and survival of *Penaeus monodon* challenged with white spot syndrome virus. *Fish Shellfish Immun* 15:297-310.



More information

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## IDAH High Moisture Shrimp Feed Pelleting Process

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Pellet Mill PM-53F

+

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+

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=

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