Stabilized Rice Bran

An Innovative Ingredient for Meat Emulsions & Beyond

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With the planet’s population continuing to grow by more than 70 million people a year and the quality of life in developing countries improving, the demand for food and meat is growing more than proportionally. It is not a far stretch to predict that 25 years from now, to provide wholesome nutrition for an estimated 9.3 billion people may require at least 50 percent more food than today. To meet the needs of the rapidly developing food business, suppliers of functional ingredients need to create a dynamic vision for the future and identify trends that will enhance the profitability of the entire value chain. This includes finding new and novel ways to utilize previously unassuming waste material such as rice bran.

Rice bran is well known and researched. However, stabilization technology has only recently become available which has catapulted rice bran into the limelight for functional and nutritional use in processed food and meat products. Food and meat processing today is confronted with a number of health considerations and the emerging need to find solutions in such areas as sodium reduction, fat replacement, meat-protein alternatives, protein fortification and ‘green-label messaging’. Because of its health benefits, rice bran has become a popular ingredient in dietary supplements and functional foods. Now, this ingredient is increasingly making crossovers into mainstream foods such as processed meats and meatless varieties.

The behavior of stabilized rice bran in very complex meat emulsion systems is both simple, yet very difficult to explain because of the lack of adequate scientific confirmation. To date, R&D departments of large food and meat manufacturers, as well as universities and institutes, have empirically evaluated stabilized rice bran. It is only a question of time before scientific papers will be published. In the meantime, empirical experience will drive most of the introduction and speed-to-market.

Stabilized rice bran has great potential for functional properties such as enhancing and stabilizing meat emulsions and coarse ground meats such as burgers and patties. But, perhaps equally important, the ingredient has a very friendly ecological footprint and environmental image that can be reflected in the label declarations on consumer food and meat packaging.

Soy Saga

Processed meats consume half of the world’s annual output of one million-plus metric tons of functional soy protein. But, concerns over soy’s continuing price increases, its allergic potential, conflicting health claims and the emergence of newer functional systems threaten its hegemony.

Despite the multitude of lifestyle foods, nutraceuticals and vegetarian foods that are formulated with soy protein, the primary application for soy protein remains processed meats. The health food category gets the attention, but it is fair to say that the soy protein industry would probably collapse without the global market for processed meat applications. More than 210,000 metric tons of soy protein isolate is used annually for emulsified meat formulations such as hot dogs and deli meats; not to mention large soy protein usage in coarse ground and whole muscle meats products like patties and roast beef. Serious issues surrounding meat production and ingredient technology are impacting soy’s world market. Soy protein isolate has a proven track record for use in these formulated meat products, though consumer acceptance in some countries such as the U.S. remains questionable. Also, many meat processors are looking for ways to replace expensive vegetable protein sources by substituting it with equally well performing lower cost solutions.

It can be reasoned that soy protein’s inclusion levels in Eastern Europe, South Africa and some Asian countries have peaked due to the detrimental effect inflated inclusion levels have to product integrity. As living standards improve, a linear decline of soy protein will follow. In this sense, it is probably true
that the dilution of soy protein offers a sustainable solution for stabilized rice bran.

First, a look at how the underlying issues shake out, followed by a review of the emerging ingredient system that is already impacting the non-meat protein usage among meat processors.

**World Food Price Hikes**

According to FAO projections, consumers worldwide will face uprising food costs for at least 10 years. The forces that drive up costs, including functional ingredients, are energy that trickles down increasing the cost of everything, as well as the huge demand for meat and dairy in rapidly developing countries such as China, India and the Philippines. The cost of livestock feed and the demand for raw materials to make bio-fuels or ethanol have also played havoc on many staples and specialty foods alike. Grain prices, including wheat, rice and corn, will probably remain at elevated levels due in part to the surging demand in Asia and the diversion of farms growing crops for bio-fuel. Subsequently, rising food prices are stressing economies all over the world and, as usual, poorer countries have exacerbated hunger and increased civil disobedience and political unrest.

Livestock creates an enormous biological footprint. The UN Food and Agricultural Organization estimates that grazing and feed production uses 30 percent of the planet’s land surface and a significant share of its global water resource. Demand for all muscle foods (beef, pork, poultry, fish) is rising in developing countries. These countries will account for the greatest increase in population. The soy protein industry has directly and indirectly echoed the special-interest groups by using these facts to leverage consumer concerns about meat’s environmental impact.

**Meat Consumption**

It is about time that the meat industry proactively addresses the perceived relationship between meat products and the incidence of obesity, cardiovascular health and other degenerative diseases. The modern consumer will seek preferences for environmentally safe and healthy meat products that maintain product quality, integrity and affordability.

Although it is true that affluent consumers are trending toward greater consumption of organic foods and non-meat protein alternatives, a majority of the world’s population retains a strong affection for meat products. Not only is global consumption of processed meats increasing along with developing countries growing per-capita income, it is also known that soy-based vegetarian foods are struggling to compete on price with traditional meat products.

Without any economic incentive, why should consumers in affluent societies purchase foods that are based on analogue technology?

FAO predicts a dramatic increase of meat consumption by as much as 50 percent for the next 30 years. The developing countries are especially responsible for making up lost ground in their appetite for meat and meat products. This phenomenon will create a heavy environmental burden but will simultaneously open up a great potential for functional ingredients that allow a certain amount of lean meat replacement without affecting organoleptical properties.

**The Ingredient Angle**

Soy protein marketers have bombarded the meat industry with a clear message: soy protein as a key human nutrient reduces environmental impact by eliminating the wasteful conversion of soy into animal feed and secondarily into meat. How wrong they were! The soy protein industry’s position has become a double-edged sword. Functional soy manufacturers need the processed meat industry to sustain their own existence, but their business strategy focuses on replacing lean meat with soy-based alternatives. Moreover, at the lower end of the analogue category, burger patties based on low-cost textured soy protein (TSP) are becoming more expensive than the lower-end meat-based alternatives. Thus, the soy protein industry’s green message about vegetable protein-based foods being cheaper doesn’t always resonate with consumers.

Many industry observers have suggested that such messaging is part of the reason North American meat processors haven’t fully embraced functional soy protein. Despite the influence of bio-fuel food/feed competition, the price of lean meat is still relatively low and consumers in affluent societies can afford to include costlier muscle meats as a routine part of their diets.

The increased awareness and manufacturing capacity of stabilized rice bran puts downward pressure on soy ingredient prices because of the risk of losing substantial market share. The rather quick rise of stabilized rice bran as a functional equivalent and cost-efficient substitute to soy isolate has subdivided senior management of soy protein marketing companies. All of a sudden, soy isolate hegemony is
challenged and meat formulations now have a viable alternative to serve as a lower cost option.

A strategy decision is not easy to make for soy protein manufacturers. They can either take the high road and stay true to a single soy solution or team up with the lower cost alternative and offer functional blends of stabilized rice bran and soy protein. One thing is certain, if soy manufacturers stick to the single solution offering, a great many specialized blending companies will enter the market place and supply convenient solutions in the form of unit packs.

There is obviously a tremendous potential of industry interest and it is reasonable to expect that this surge will bear fruit when stabilized rice bran gains further popularity as a meat emulsion enhancer over the coming decade.

Rice: “Soy’s Non-Allergenic Competitor”

Anaphylactic reactions are severe allergenic responses that occur when the body’s immune system overreacts to a particular allergen. These reactions may be caused by food, insect stings, medications, latex and other substances. There is strong medical evidence that food allergies are increasing among Western populations. Now, both the FDA and the FSIS (Food Safety and Inspection Service) are taking food allergies seriously. The FDA has identified nine food categories (see box below) that account for more than 90 percent of all food allergies.

The Top Nine Food Allergens

- Peanuts
- Soybeans
- Milk proteins (casein)
- Eggs
- Seafood (fish, shellfish)
- Sesame seeds
- Tree nuts (almonds, cashews, hazelnuts, pecans, walnuts, pine nuts)
- Wheat
- Sulphite

Soy protein at inclusion levels from 1 to as much as 12 percent are often the dominant ingredient in processed meat and meat analogues. For example, in South Africa, an inclusion level of 10 percent soy isolate in hot dogs is quite normal. Here, soy protein counts as part of the minimum meat protein requirement. In a veggie hot dog, a soy isolate inclusion level of 10 percent is needed to simulate meat texture and appearance. Concern over food allergens make it difficult for soy to be considered the lead protein in these applications.

Hypoallergenicity is the main reason that countries such as Sweden and an increasing number of companies have almost completely eliminated soy protein ingredients from their processed meat products and replaced it with pea protein and/or rice protein. In addition, there is a functional potato protein isolate that is looming in the horizon.

An increasing amount of consumers prefer convenience foods while insisting on the use of natural, healthy ingredients. This has created a growing demand for functional ingredients with superior nutritional profiles. A potential challenger for soy protein in processed meat applications is a newly developed functional, as well as nutritive ingredient made from rice.

Rice Innovation

Rice has been a traditional nutrient dense food source for nearly all cultures for thousands of years. Until recently, rice bran, a by-product of rice milling, did not contribute to greater value and was considered unfit for prolonged storage and consumption. It is probably true that rice bran is the world’s most underutilized food source. Fortunately, new proprietary technology has become available to neutralize the enzymes that cause rancidity. For example, methanolic treatment of volatile rice oil components is one of the stabilization steps that results in a superior natural ingredient that delivers nutritive fiber, a rich source of B complex vitamins, minerals, phytosterols, over 100 antioxidants and a stable oil and protein fraction.

Traditional rice milling methods caused the kernel enzyme lipase to leach into the bran, inducing almost immediate oxidation and rancidity and thus rendering it unfit for human consumption. Since a new chemical-free stabilization technology has become available, rice bran is no longer viewed as a waste material. This proprietary technology now has given the world a premium ingredient known as stabilized rice bran.

This ingredient is showing great potential in food and processed meat products. It is likely that stabilized rice bran is about to challenge the leadership of soy protein isolate in emulsified meat such as hot dogs as well as coarse ground meat products like burgers and patties. After all, this segment has the largest
potential and probably is ready for (part) replacement and quick conversion.

**NutraCea**

NutraCea is a pioneering food ingredient company that has developed proprietary and patented application technology. They have an ambitious program to target processed meat applications using stabilized rice bran as a key ingredient to optimize product quality. Together with wheat, soy, potatoes and corn, rice is part of the world’s main crops that nourishes billions of people. Following the successful completion of a series of research studies at renowned universities and plant tests, NutraCea’s stabilized rice bran will be a welcome addition to the portfolio of food technologists looking for a replacement or enhancing soy isolate.

The innovative stabilizing technology will put NutraCea on a fast-forward path who will increase production capacity to approximately 100,000 metric tons by the end of 2009. But there is much more to come; by utilizing a by-product that previously had been considered worthless, it is logical to anticipate that traditional rice growing countries will quickly want to join and add sustainable value to their own locally grown rice bran.

**Combining Superior Nutrition and Performance**

NutraCea is about to embark upon an inclusive dynamic vision process that brings together premium functionality and health attributes coupled on major cost savings compared to soy protein isolate solutions. Stabilized rice bran, which will be marketed under the trade name **RiBran Isolate**, is available in a granular form (**Texturizer 100**), powder-fine (**Texturizer 200**), as well as powder-extra fine (**Texturizer 300**). The latter types allow the ingredient to be used in a wide range of specialty blends that are gaining popularity for direct addition for both meat-emulsion and coarse-ground meat systems.

Stabilized rice bran has been approved by USDA-FSIS for use as a binder in various meat and poultry products (June 23, 2008). This approval opens the way for U.S. meat processors to formulate this functional ingredient in products such as sausage, chicken patties, meat balls, meat loaf and meat patties.

RiBran Isolate is a non-allergic binder ideal for use in processed meat products. The stabilization and texturizing capacity of stabilized rice bran is remarkable and meat processors who have replaced soy protein in their formulas for reasons such as eliminating allergic warning labels have discovered this rice derivative alternative to be a favorable replacement. In addition, processed meat manufacturers continue to look for “natural and green” ingredients that are label-friendly without undesirable organoleptical changes.

RiBran Isolate is a combination of naturally occurring soluble and insoluble fiber fragments and contains a balanced spectrum of hypoallergenic nutritive protein. It is cholesterol free and has a blend of saturated, mono- and polyunsaturated fats which can prevent cardiovascular disease by improving serum cholesterol levels. In addition, it has naturally occurring sources of antioxidants such as γ-oryzanol, tocopherols and phytosterols which are potent hurdles in preventing rancidity in processed meat products. The latter can be determined by measuring its peroxide value, iodine value and free fatty acid content. Furthermore, the use of stabilized rice bran beyond the function as a texturizing stabilizer in emulsified and coarse ground meat products can be seen as a natural solution unlike artificial additives such as butylhydroxyanisole (BHA) and butylhydroxytoluene (BHT). Subsequently, the antioxidative properties of stabilized rice bran taps into the “natural food” trend and groups this ingredient with other natural antioxidants such as herb extracts, tocopherols (vitamin E) and ascorbates (vitamin C).

On a side note, a comparatively high percentage of protein (15%) is present in rice bran that, in principle, can be isolated to a protein content of up to 90 percent with a well-balanced amino acid composition. As such, rice protein is very suitable for a plethora of health foods, including formulated meat analogues. The functional properties are on par, if
not better, than other sources of vegetable protein such as soy and pea. The market for alternative proteins is evolving rapidly and functional rice bran and possibly its derivatives, high quality rice protein isolate or concentrate, has a real potential to make its way into food solutions for future markets.

**A Natural for Meat Inclusion**
The emergence of the novel stabilized rice bran with approximately 29 percent total dietary fiber not only has beneficial physiological effects, it also provides technological advantages including offsetting the negative texture and flavor effects of fat reduction.

RiBran Isolate contains a dietary fiber with functional, physicochemical, sensory, organoleptical and texture values in both emulsified and coarse-ground meat products. The ingredient has proven texturizing abilities and will offset the detrimental effects of high inclusion level soy protein containing meat products. For products such as chicken patties, an inclusion level of 1–3 percent stabilized rice bran resulted in a significant decrease in cook loss values while increasing juiciness and texture. While there were no adverse effects on sensory attributes such as color, flavor and bite, at increasing levels of stabilized rice bran, there was a tendency to develop a slight off-white color in all-breast chicken formulas.

For the sake of clear understanding, it is important to agree on the definition of a meat emulsion. In a meat emulsion, fine fat droplets are dispersed in an aqueous medium containing soluble proteins, other soluble muscle constituents, segments of muscle fibers and connective tissue fibers. In a stable emulsion, each fat droplet is coated with a thin layer of soluble protein, which has been released into the aqueous medium from the muscle fibers.

It is known that myosin and actomyosin in a meat emulsion largely determines the quality and strength of binding and structure. Besides the role of salt and phosphate in extracting optimum amounts of salt soluble protein (SSP), thermalization is also an important variable. It has been reported that slow heating rates allow more protein:protein interactions thus form a more coherent and stronger 3-dimensional gel or matrix.

Because of price competition and affordability, over the past 20 years, many meat processors have either aggressively reduced the inclusion level of lean meat and/or substituted with less technologically favorable meat cuts or introduced mechanically deboned meat from lower cost options such as chicken or turkey. Subsequently, to offset the less available high performing meat proteins for meat emulsion structure and stability, supporting ingredients such as soy isolate, starches and hydrocolloids have been successfully introduced to augment or enforce the myofibrillar meat proteins. Despite reliable and good performance properties of soy ingredients in emulsified meat products, an antagonistic behavior develops in the texture when increasing amounts of meat is replaced.

Within the soy protein isolate category, relatively huge performance differences can be observed. For example, high-gelling soy isolates such as Supro 500E are better suitable for low protein content and stretched meat formulas. On the other side, low viscosity soy isolates such as Supro 595 are better suited for high meat content sausage, albeit at lower levels of inclusion. In other words, high gelling soy isolates for high meat replacement and low gelling soy isolates for low meat replacement.

Since stabilized rice bran cannot be considered a specific emulsifier or gelling agent, but rather a functional ingredient to enforce the total meat emulsion, it can be reasoned that at high lean meat replacement levels, the meat texture needs to be

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<th>Stabilized Rice Bran (SRB) Data Sheet</th>
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<td>NutraCea stabilized rice bran (SRB), with the germ, is naturally processed to deactivate the enzyme that causes rancidity to ensure oxidative stability. SRB is all-natural with no chemical additives.</td>
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augmented with a high-gelling type of soy isolate or soy concentrate. For these applications, stabilized rice bran can be used with soy isolate preferably in a blended form. As such, new functional blends are being introduced and convenience can be provided to the meat processor by using Unit Pack systems that offer a total concept solution. For example: R1Bran Isolate 70%, soy isolate 20% and sweet whey powder 10%.

**Competing for Share of Formula**

At first impression, functional rice bran isolate and soy isolate seem to compete for share of formula. This indeed is seemingly true for processed meat products with a relatively low inclusion level. For these premium products, it is a question of either rice bran isolate or soy isolate. After all, it is well known that ingredients that are able to synergistically increase dry matter content in an emulsion generally contribute to improving quality. However, at reduced levels of lean skeletal meat, there is a need to reinforce the emulsion or meat batter with increased levels of functional ingredients. For these products, soy isolate and rice bran isolate can be considered synergistically; when properly applied, soy protein isolate can provide a mechanism to reduce surface tension at the fat:water interface, while rice bran isolate absorbs and immobilizes free- and extracellular water together with added formula water. For all these variables, rice bran can be considered a welcome tool for alternative solutions while significantly improving bottom-line performance and economics.

The properties of functional ingredients in complex meat emulsion systems are very important since their performance can either be beneficial or detrimental. There are a number of variables that can affect the performance of stabilized rice bran. All emulsified meats, such as bologna and hot dogs, go through a finely comminute process which ultimately leads to gelation. Gelation itself is a two-step heat treatment process involving dissociation of the protein molecule followed by aggregation which forms a gel network or matrix. In principle, heat-induced gels can be divided into two types: thermoset or irreversible and thermoplastic (thixotropic) or reversible. Emulsified meat products always are considered thermoset gelation. The properties of solubilized meat proteins and to a certain degree, the swollen myofibril proteins, along with added non-meat protein ingredients play a very important role at surfaces or interfaces. Nearly all food products that contain immiscible substances such as water and oil/fat need protein to maintain product integrity.

Solubilized myofibril protein and some other functional animal or vegetable protein ingredients have a certain molecular structure that provides an affinity for substances on either side or the interface. The result is an emulsion. Emulsification is the process of one liquid being dispersed as small droplets or globules within the other. The water phase may be a solution of salt, sugars and other water-loving or hydrophilic ingredients such as the fiber fraction of stabilized rice bran. The oil phase may contain fats, oil and other fat loving, or lipophilic substances such as the rice oil fragments of stabilized rice bran. The emulsion itself will become an important structural part of the matrix.

Proteins are amphipathic macromolecules, i.e. they have hydrophilic and hydrophobic regions. The hydrophilic region is usually referred to as the head group and the lipid portion is known as the tail end. This is the principle molecular basis for interactions at the water and oil interfaces. Thus, proteins can be considered to act as surfactants in forming emulsions, foams and stabilizing meat batters.

All emulsifiers have an electrically charged or polar end and a non-charged or non-polar end. The polar end is hydrophilic whereas the non-polar end is lipophylic. The result in a water-oil mixture is that the emulsifier dissolves part of itself in water and the other part in oil. Energy is required in the form of high-speed rotating knives or blades to reduce the fat or oil into small particles, preventing coalescence and allowing adsorption of the protein ingredient and subsequent formation of a stable emulsion.

What sets stabilized rice bran apart from typical vegetable proteins such as soy isolates is that its rice fiber fragments are very eager to absorb water while the rice oil quickly show lipophylic behavior. Knowing this, it is important to first optimize extraction of the myofibrillar salt soluble protein by salt and phosphate together with the appropriate amount of water or ice. However, the functionality of stabilized rice bran goes beyond water absorption properties of the fiber component. By separating the rice fiber by means of centrifuging from the oil and protein
fractions, the direct influence and properties of the single rice fiber can be measured. The water holding capacity of rice fiber itself is not significantly better than other fibers such as derived potato and oat. Of course, the fiber fraction is a welcome bonus but it will not fully explain the superior binding or stabilizing properties of rice bran isolate. There is more than meets the eye.

On a side note: Stabilized rice bran, like soy concentrate, also contains fibers. However, unlike soy protein concentrate, stabilized rice bran does not contain unfavorable residual carbohydrates such as stachyose and oligosaccharides raffinose that may cause flatulence and negative soy flavor taste associations.

Ribran Isolate is Not a Déjà Vu

The term functionality refers to the functional demands made on food and meat products like the desired properties such as fat binding, water holding and structure forming capabilities. It is clear that these functional requirements are only marginally related to similar physicochemical protein and fiber properties in aqueous solutions. Subsequently, this means that functional requirements are frequently solved by trial and error through the addition or elimination of arbitrarily selected functional ingredients. And yes, for every new sausage formula, this empirical procedure has to start all over from base one.

Meat technologists have grown up by determining the “performance quality” of soy isolate and soy concentrate by making pre-emulsions like 1:5:5 and 1:4:4. For example, by emulsifying 5 parts water and 5 parts fat with 1 part soy isolate, a quick indication of how the fat and water holding capacity performed under pasteurization or sterilization conditions can be obtained. Likewise, combining 3 to 4 parts water with 1 part soy isolate would give an indication about consistency and gel strength.

When a new functional ingredient arrives on the scene, it is only logical that meat technologists evaluate it in a similar fashion. For stabilized rice bran, measuring emulsification and gel strength is based on a different mechanism. Stabilized rice bran is a unique integrated combination of protein, oil and fiber that are configured to independently react with most constituents of a meat emulsion. Moreover, the individual components of stabilized rice bran synergistically react with the meat emulsion aggregates upon heating of the product. Most likely, when the thermalization cycle reaches about 50°C and higher, the individual components react and provide structure and stability to the emulsion.

As it is the case with other emerging novel ingredients, most data use empirical observations. True scientific reports will do no doubt follow a few years from now. In the meantime, stabilized rice bran is quickly gaining acceptance and reformulated sausage and coarse ground meat products are being introduced in a rapidly increasing number of countries.

It has been determined that rice protein enhances emulsification capacity by stabilizing or immobilizing the fat/oil droplets that are finely distributed throughout the meat batter matrix. The protein content of stabilized rice bran (15%) is about the same as sweet whey powder. Whey protein is very suitable to mimic fat globules (microparticulation) that are known to improve mouth feel, texture and general rheological properties. Sweet whey powder, including demineralised versions, has been used for many years in food and meat products and together with stabilized rice bran, offers beneficial effects. The ability of rice protein to encapsulate oil while maintaining structural integrity enhances its value throughout the thermal processing cycle for stability, improving yield and/or reducing purge while reducing costs.

Inclusion Levels

For premium emulsified meat products, an inclusion level of 1 to 2 percent stabilized rice bran is sufficient. The functional ingredient performs best when added in dry form directly into the chopper or mixer-blender. The coarse or granular type of Ribran Isolate is especially suitable since it does not contribute to any dusting and provides almost immediate particle breakdown and very rapid hydration that is also assisted by the blending or chopping friction. Subsequently, it quickly increases water absorption.

Unlike soy protein isolate, which at increasing levels of addition have a tendency to proportionally increase pH and weaken meat color, stabilized rice bran will not affect these variables. On the contrary, because of the strong antioxidative properties of stabilized rice bran, shelf life and color generally improves in cured meats. Also, formulas that are based on mechanically deboned chicken or turkey meat requires a relatively
low inclusion level of stabilized rice bran at < 2.0 percent.

Emulsified meat products that are formulated on a low amount of lean meat content (i.e. less than 30 percent) typically require inclusion levels of 3 to 4 percent. Sausages with even lower lean meat content can be formulated using soy protein isolate to enhance gelation while using stabilized rice bran to immobilize water and to safeguard organoleptical properties such as texture. For low-meat emulsified sausage, an inclusion level of 2 percent soy protein isolate and 3 percent stabilized rice bran is generally a good starting point.

It is known that high inclusion levels of soy protein isolate reduces the typical cured color of processed cooked meat products. Stabilized rice bran will somewhat weaken the cured color after 45 days of storage though the color weakening is of less intensity compared to soy protein based formulas.

After 2 and 4 weeks of refrigerated storage, purge is significantly lower when stabilized rice bran is used at 3 percent compared to the control product. When refrigerated storage is increased to 12 weeks, formulas containing as little as 1.5 percent stabilized rice bran also showed significant less purge compared to the base control formula.

Although stabilized rice bran can be used as a stand-alone functional ingredient in emulsified and coarse ground meat systems, combinations with dairy protein, soy protein, hydrocolloids and deheated mustard flour are organoleptically well balanced and provide very satisfactory yield results.

In terms of shelf life, it can be noted that stabilized rice bran contains considerable amounts of antioxidative flavonoids, not to mention the inherent benefits of superior freeze/thaw properties which are excellent for hot dogs sold to the so-called “wet markets” in developing countries that are refrigerated for up to 90 days.

While stabilized rice bran does not offer as high an emulsification capacity as some animal or vegetable proteins and does not have the same water binding properties as certain fibers, at moderate levels of inclusions, stabilized rice bran most certainly provides excellent functional solutions with regard to cost, texture and flavor when used in a wide range of emulsified meat products.

The optimum level of stabilized rice bran mainly depends on the lean meat and fat level. For high lean meat sausage, usually an inclusion level of 1.5 percent will be sufficient. For medium lean meat and a fat level of approximately 25 percent, a 3 to 4 percent inclusion usually suffices. At these levels, the end product generally shows similar yields as the control product made with soy isolate. The same is true for properties such as texture, chewiness and hardness. However, taste panels preferred meats formulated with RiBran Isolate because of its more meaty appearance and note of sweetness. Generally speaking, consumers prefer the slight sweet note compared to the typical soy flavors that filter through when soy isolate is used at high levels of inclusion.

Sensory evaluation showed that trained panelists were unable to detect differences such as interior firmness, interior cohesiveness and rancidity between the base control without added functional ingredients to the various test products containing 0.5 to 3.5 percent RiBran Isolate during the entire storage period of up to 90 days. However, it should be noted that at RiBran Isolate inclusion level levels of 3.5 percent and higher, the sausage is perceived somewhat less juicy compared to the control formula.

Because of the great many variables such as the specific type of processing equipment, formulation and availability of raw materials, it is very difficult, if not impossible, to give precise application and dosage information. For example, soy concentrate generally performs better in a low-energy emulsion system while soy isolate performs better in a high-energy emulsifying system.

**Protein and Flavor Encapsulation**

Proteins and some other functional ingredients contribute to physicochemical properties that guide the behavior and performance during emulsion preparation, thermalization, storage and finally meeting or exceeding consumer expectations. It is known that extrinsic conditions such as temperature, pH, salt, hydrocolloids, surfactants and water, together with processing variables can greatly influence performance dynamics. For example, the availability of sufficient free water is often neglected. During emulsification, the presence of ingredients and additives compete for water which will often create too much friction early on in the processing cycle.

In addition to the protein’s complex conformational structure that assembles a coherent and stress-stable emulsion or meat matrix, proteins are also an important source for interactions with flavor compounds. This feature can be synergistic or antagonistic. Flavor encapsulation by protein can protect unwanted flavors from filtering through during thermalization, storage and point of consumption.
Dairy protein are superior in protecting and enhancing undesirable flavor development because of their good rheological and surfactant properties. Additionally, it should be mentioned whey protein has the ability to mimic fat by means of microparticulation. Soy protein on the other hand, is considered antagonistic when it comes to undesirable flavors. Specifically, the medium-chain aldehydes bring out the beany off-flavor of soy protein ingredients.

Stabilized rice bran can balance flavor better. A perfect solution would be to use a small amount of sweet whey powder to balance flavor favorites. Extensive consumer paneling has indicated that a strong preference is given to hot dog products formulated with RiBran Isolate mainly because of the lack of detectable and undesirable soy flavors.

**A Case Study**

It is no secret that meat processors are faced with a balancing act between choosing ingredients that deliver performance and getting the health positioning they want. The consumer gets the nutritional enhancement and improved finished product while the producer gets the cost savings. Recently, the increasing cost of raw materials have fallen on the producer who simply cannot pass the increase onto the market due to the static daily salary of the masses in the lower end Asian countries. Fear of doing so and the losing market share are great which results in a steadily dilution of margins.

A number of research studies at Iowa State University, the Meat and Fat Research Institute in Poland and both pilot as well as full-scale plant evaluations in Europe, Philippines and Thailand confirmed that stabilized rice bran inclusion level of up to 4 percent has the ability to immobilize or bind water at higher intensity for a longer period of time than soy protein isolate.

Mr. Bernard Chu, CEO and owner of Turris Philippines, one of the largest food ingredient suppliers in the Southeast Asian region, had his team of food technologists working with stabilized rice bran to fully endorse its value in low cost Asian style meat products. Mr. Henry Martin Glover, senior meat scientist and technical & operations director for Turris Philippines, has spent the past twenty years working throughout the Southeast Asian region. Mr. Glover, who is a highly sought after and respected meat scientist, has stated that producing hot dogs or any processed meat product including the high meat contents that are used in the USA, Europe or Australia with stabilized rice bran has the ability to reduce the cost of the recipe compared to soy protein isolate. But, he firmly believes that the true value of this unique product are considerably demonstrated in the low cost and subsequently low meat products sold in the less well off Asian countries.

Mr. Glover states these cost driven markets are constantly looking for new innovations to achieve or simulate a quality product at an acceptable price that suits the purchasing power of the consumer. He is convinced that this new innovation is a welcome addition to the world of processed meat. In the Philippines, hot dog is the number one processed meat with a total of 750mt being produced per day across the country.

Mr. Glover says that it is important to know how stabilized rice bran functions when you are first introduced to it since it does not show the same attributes as soy isolate. Simply evaluating it at lab level by means of gels, fat emulsions or water absorption will show no comparative results. The functionality of stabilized rice bran comes during the thermal process. Its highly concentrated fiber content becomes bonded and linked under the thermal process giving a strong texture and great water and moisture holding capacity that is even better than soy isolate. In the Philippines, this attribute is put to the test in the typical wet market environment. The frozen processed meat products can go through as many as five freeze-thaw cycles before being purchased. The considerably improved purge results of stabilized rice bran also lend a hand to improving food safety aspects.
The Philippines and neighboring countries have picked up very quickly on the inherent quality and application properties of stabilized rice bran. During the actual meat emulsion process, it has been determined that stabilized rice bran is an ideal ingredient to manipulate thermodynamical considerations. It is a well known fact that each and every meat emulsion has a certain preferred time: temperature optimization in which processing equipment and ingredients can be used to reach preferred temperature specifications.

Immediately after the addition of the stabilized rice bran into the chopper or blender, the rice fiber starts to attract water and swells. This phenomenon can be described as a gritty look and feel. However, during the cook cycle, the gritty appearance and taste will completely disappear.

It can also be noted that high inclusion levels of stabilized rice bran will affect the typical cured meat color just like soy isolate. High inclusion levels of soy isolate generate less curing color as a result of less availability of meat myoglobin and the influence of the soy’s high pH. For high inclusion levels of stabilized rice bran, it is the color of the ingredient itself that will darken the color somewhat but color enhancers, many of which are also used when soy ingredients are used, can easily correct this.

### Cured Meat Color Enhancers:
- Fermented Rice (Monascus Purpureus)  
  Aka: Ang-kak or Red koji  
- Beet Root Extract  
- Blood Albumen  
- Sandalwood Extract  
- Paprika Extract  
- Erythrosine  
- Carmine (Cochineal)  
- Red 2G

### A Practical Example
The following may serve as a reformulation example for a typical Asian low-cost hot dog containing low meat content: lean meat (20 percent), fat (14 percent) and added water (36 percent). 3 percent soy isolate and 2 percent food starch was replaced weight for weight with 5 percent RiBran Isolate.

Stabilized rice bran was added into the chopper immediately after the fat. Since stabilized rice bran hydrates very rapidly and takes up water quickly, it is important to ensure that sufficient free processing water is available in order not to overheat the emulsion temperature.

Compared to the control hot dogs that contained soy protein, the RiBran Isolate formulated product was rated only slightly softer in texture. However, the flavor scored much better than the soy isolate control because stabilized rice bran appears to hold flavors much better. Additionally, the RiBran Isolate hot dogs were noticeable sweeter.

For premium hot dogs that contain a total of 60% of lean meat and fat, 3 percent soy isolate was replaced weight for weight with RiBran Isolate. Again, it slightly altered the color of the emulsion but during taste tests, no panel member could detect which contained soy isolate and which one contained RiBran Isolate.

### Summary
Backed by application research at leading meat institutes and universities in the USA, Poland and Asia, as well as ongoing market success stories, it can be concluded that stabilized rice bran offers excellent opportunities to fully or partially replace soy ingredients.

RiBran Isolate is very user friendly and can be ideally added as a non-dusting dry powder that does not have the complicated pre-emulsion of pre-gel preparations that are often required when soy ingredients are used. RiBran Isolate is also very label-friendly with no allergy and GMO issues. Furthermore, RiBran Isolate is nutritionally equal to meat, eggs and milk and readily available at significantly lower prices.

Looking towards the future, what is ahead for stabilized rice bran as a functional ingredient in regards to both usage and pricing? At this point in time, the full picture is complicated but long-term trends are very encouraging. For starters, stabilized rice bran allows a “green” labelling while the ingredient is markedly lower in price than soy protein isolate. U.S. and E.C. origin soy protein isolate will continue to increase in price which will definitely encourage meat processors to find alternative solutions. It should also be mentioned that it will become increasingly more difficult to source non-GMO soy ingredients. With that in mind, stabilized rice bran can successfully replace soy protein isolate up to 4.0 percent inclusion level on a weight for weight basis. The most desirable benefit, besides the “green” labelling, is the significant savings of ingredient costs while improving or maintaining quality parameters.

As a related parallel development, RiBran Isolate is currently being evaluated in coatings and batter for deep fried foods. Reports are showing that a relatively small inclusion of stabilized rice bran in
batter mixes has the effect of extending the batter due to higher water absorption while simultaneously blocking fat uptake. The reduced oil uptake significantly impacts the nutritional content while costs associated with reduced oil usage in the frying oven are lowered.

Conceptually, RiBran Isolate can be used for the following meat emulsion scenarios:

- Full replacement of soy protein isolate. Depending on lean meat formula share, the inclusion level varies from 1 to 4 percent.

- Partial replacement or reinforcement of soy protein isolate. For example, for a low lean meat content formula, a 3 to 4 percent inclusion level of stabilized rice bran can be reinforced with an additional 2 to 3 percent soy protein isolate.

Conclusion: RiBran Isolate has a great potential to develop into successful business propositions for food and meat applications providing the following plethora of advantages:

- Cost efficiency
- “Green” labelling
- Non-GMO
- Low/no environmental footprint
- No allergy responses, hypoallergenic
- A natural ingredient abundantly available throughout the world
- Antioxidative properties
- No negative flavor associations
- Maintains or enhances end-product sensory quality
- Stable shelf life of 1 year minimum when stored at controlled warehouses
- Enhancing nutritional benefits
- Allows processing tolerance and ease-of-addition / No dust
- Stable, sustainable and reliable supply

RiBran Isolate will gradually be introduced to select markets while NutraCea establishes a new foothold in these emerging markets through additional research and development studies to further optimize product guidance and technological support. After all, it is not often that a true “traditional innovative” functional ingredient is introduced that combines emulsion stability, antioxidative support and nutritive performance.

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**Henk W. Hoogenkamp**

*Author Hoogenkamp is former President of DMV Campina and Senior Director Strategic Technology of DuPont Protein Technologies. Hoogenkamp has written several books on food and meat processing (www.cabi.com; www.editorialacribia.com). Henk is a contributing author for prestige publications, and developed a large range of highly successful functional ingredients based on dairy and vegetable protein.*

Hoogenkamp1@aol.com

October 2008
Bio

Henk W. Hoogenkamp has been President of DMV Campina USA (1983-1990), and Senior Director Strategic Technology at DuPont Protein Technologies (1990-2005). He left an unparalleled legacy by inventing and creating world’s first science based protein supplement RiFit Total Milk Protein for top sport performance as well as hydrolyzed milk and soy protein ingredients for both nutraceutical, beverages and processed meat applications.

As a passionate lifelong student of integrating food science into food technology, Henk uniquely combined his curiosity to capture the essentials of exceeding expectations for his world base of customers.

The ideologies of Henk Hoogenkamp, coupled on his charismatic and exemplary attitude, truly can be considered unmatched in motivation, commitment and dedication in the pursuit for creating and re-creating a wide spectrum of food products, including menu board favourites for world’s largest quick service restaurants.

As a visionary, Hoogenkamp always seeks out new challenges for improvement and change by adapting mechanisms that stimulate discontent with the present. Hoogenkamp is an accomplished author with 8 books on the functional use of milk and soy protein ingredients for processed meat and lifestyle foods, not to mention a great many articles and opinion papers on topics ranging from affordable nutrition, ethanol energy, ingredient marketing and strategic positioning of nutraceuticals and beverages.

Henk Hoogenkamp is a much sought-after keynote speaker at world-renowned conferences and forums on topics such as creating sustainable and commercially successful functional ingredient concepts. In a way, he walks the delegates and participants through a long and winding road of concise and factual information about food and meat products for both mainstreams as well for specific health issues that need to be addressed.

References

- PHD Technologies LLC; Testing for USDA approval of Rice Bran in standard of identity meat products.
NutraCea Statement Regarding Arsenic

Recent articles in the media have called into question the safety of rice products, including those manufactured by our Company. These articles suggest an association between arsenic in rice and cancer. All foodstuffs, including rice, contain trace amounts of naturally occurring arsenic. However, no link has ever been established between consumption of rice and cancer. The authors of these publications have based their concerns on a comparison of allowable levels of arsenic in drinking water to levels found in rice products. Such comparisons are not appropriate as bioavailabilities of arsenic in each are substantially different.

Rice products have been consumed as a food staple by much of the world’s population for thousands of years. Its safety and contribution to human health and well-being is well established. It is unfortunate that the articles in question have drawn inappropriate conclusions to raise concerns about rice products in the absence of scientific evidence. We stand behind the safety and wholesomeness of our products.

Phoenix, AZ - August 28, 2008
RiBran Isolate Product Data Sheet

NutraCea RiBran Isolate products are all-natural stabilized rice bran and germ and contain no chemical additives. They are processed with a proprietary process to ensure oxidative stability and maximum meat enhancement performance.

Guaranteed Specifications

<table>
<thead>
<tr>
<th>Protein</th>
<th>12-16%</th>
<th>Soluble Fiber</th>
<th>2-6%</th>
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<tbody>
<tr>
<td>Fat</td>
<td>18-23%</td>
<td>Ash</td>
<td>7-10%</td>
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<tr>
<td>Total Carbohydrates</td>
<td>45-55%</td>
<td>Moisture</td>
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<tr>
<td>Total Dietary Fiber</td>
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<td>Free Fatty Acids</td>
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Microbiological

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<tr>
<th>Total Plate Count</th>
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<th>10,000 cfu/g</th>
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<tr>
<td>Total Coliform</td>
<td>Maximum</td>
<td>100 cfu/g</td>
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<tr>
<td>E. coli</td>
<td>&lt;10 cfu/g</td>
<td></td>
</tr>
<tr>
<td>Salmonella</td>
<td>Negative</td>
<td></td>
</tr>
<tr>
<td>Yeast</td>
<td>Maximum</td>
<td>100 cfu/g</td>
</tr>
<tr>
<td>Mold</td>
<td>Maximum</td>
<td>100 cfu/g</td>
</tr>
</tbody>
</table>

Physical

RiBran Isolate is available in three grinds: Texturizer 100, Texturizer 200, Texturizer 300

<table>
<thead>
<tr>
<th>Grind</th>
<th>Texturizer 100</th>
<th>Texturizer 200</th>
<th>Texturizer 300</th>
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<tbody>
<tr>
<td>Appearance</td>
<td>Granular Powder</td>
<td>Fine Powder</td>
<td>Extra Fine Powder</td>
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<td>Color</td>
<td>Tan</td>
<td>Light Tan</td>
<td>Light Tan</td>
</tr>
<tr>
<td>Flavor</td>
<td>Mild, Toasted</td>
<td>Mild, Toasted</td>
<td>Mild, Toasted</td>
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<tr>
<td>Bulk Density (g/cc)</td>
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<td>0.39</td>
<td>0.35</td>
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<tr>
<td>Mesh</td>
<td>80% through 20 mesh</td>
<td>90% through 40 mesh</td>
<td>82% through 80 mesh</td>
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