Technologies for Enhancing Functional Properties

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Functional Foods

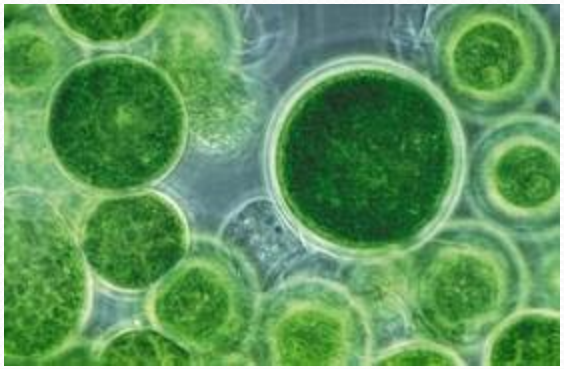
- Naturally Occurring
- Prepared by Adding Nutraceuticals

Natural Functional Foods

- Fish: omega 3 fatty acids
- Fermented Milk Products: Probiotics
- Fruits & Vegetables: Fibre, Carotenoids, Anthocyanins,
- Whole Grains: Fibre (Prebiotics)
- Rice Bran Oil: Oryzanol
- Grape Wine: Resveratrol
- Soya: Isoflavonoids

Isolating Phytochemicals from Rich Sources and Adding to Foods

- Flax seeds: Omega – 3 fatty acid (ALA)
- Micro algae: Omega-3 (DHA & EPA)
- Phytosterols: Oils (wheat-germ, sesame) & Nuts
- Isoflavones: Soya



Why Enhancement Needed

- Some substance obstructing bioavailability or activity
- Traditional process may be losing activity or recovery
- Traditional food may not be the best vehicle
- New technologies available for enhancing activity

Making phytochemical more accessible

- Soluble phytochemical less bioavailable
- Substances like fibre & phytic acid make phytochemicals less available e.g. Carotenoids, capcaisin etc.

Protect the phytochemical added

- Processes like heating at high temperatures
- Environment with low pH, many reactive substances deleterious for stability of phytochemicals
- Exposure to oxygen, light, humidity and warm storage temperature

Benefits of Omega 3 fatty acids

- Reduce all-cause mortality & various CVD outcomes like sudden death, cardiac death, myocardial infarction
- Lower blood triglycerides and blood pressure
- Prevention or treatment of asthma in adults & children
- Reduce joint tenderness in rheumatoid arthritis
- Development of brain in fetus & infants
- Reduce risk of Alzheimer's disease

Intake of Omega-3 in diet

- ALA is present in flax seeds, soya oil, nuts & seeds
- ALA needs to be converted to DHA & EPA for physiological benefits
- DHA & EPA in marine fish & certain algae
- Omega-3 like ALA, DHA & EPA are highly unsaturated
- Very prone to degradation

  under heat, light, oxidative conditions

Omega 3 enrichment

- Fish eating is the best way of getting omega-3

  100g salmon, mackerel, sardine 2000-2300 mg O3
- Many foods have been enriched with ALA, DHA & EPA
- Report in UK states that person would need to eat

  16 slices of fortified bread

  5 omega-3 enriched eggs

  6 omega-3 drinks

  1 litre of omega-3 enriched milk

  to get daily requirement of omega-3

Enhancement of Omega 3 in pork

- Flax seeds were fed to pigs
- Pigs produced pork meat containing O3
- Decreased saturated and O6 fats
- Meat contained 412 mg ALA per 100 g meat
- Control had 232 mg ALA

Enhancement of Omega-3 in Eggs

- Flax seeds to chickens for eggs with ALA & DHA
- 400-500 mg ALA with 100 mg DHA
- When fed with marine algae or fish oil DHA increases to 150 mg & small amounts of EPA 20 mg per egg yolk
- High levels of fish oil give fishy off-flavour to over-cooked eggs
- Algae oils vegetarian, no fish flavour and rich dark yolk due to higher carotenoids

Fibre

Insoluble fibre

- Cellulose: all plants especially cereals, wholegrain breads, & vegetables
- Hemicelluloses: some insoluble, e.g. in wheat and corn, others soluble
- Lignin: tough woody parts of small seeds & older vegetables (carrots)

Soluble fibre

- **Pectins** in fruits & vegetables, and most abundant in citrus fruit, apples
- **Hemicelluloses** in bran from oats, psyllium & barley
- **Gums and Mucilages:** rich sources are legumes (peanuts) & fruits; used as stabilizers & thickeners
- **Resistant Starch:** raw potatoes or certain maize; whole or coarsely-ground seeds and cereals

Role of fibre in the diet

Insoluble dietary fibres generally act to:

- accelerate the passage of food through the gastro-intestinal tract
- promote bowel movements
- slow down starch digestion and glucose absorption.

Soluble fibres generally act to:

- delay the passage of food through the intestines
- delay glucose absorption
- bind with bile acids in the intestines
- lower blood cholesterol.

Fibre and food manufacture

- Food processing/manufacturing has traditionally resulted in fibre depletion as grains are refined, fruit is peeled and insoluble fibre is softened and degraded by high heating processes such as canning.
- Either whole grain or fibre added
- Fruit juices: fibre separates so partial hydrolysis or use of emulsifiers & stabilisers
- Breads need special processes for high fibre dough for leavening e.g. high speed mixers

Role of probiotics in the diet

There are a variety of bacterial strains in different areas of your gastrointestinal tract, with beneficial functions including:

- prevention and treatment of diarrhoea, lactose intolerance, gastritis and constipation
- resistance to pathogens
- enzyme production in the large intestine
- stimulation of the intestinal immune system
- reduction of risk of colon cancer
- reduction of blood cholesterol concentration.

These functions might be reduced when there is a decline in the balance of the beneficial intestinal microflora. This decline may be due to infections or medications, especially antibiotics.

UK FSA Study

- Research at University of Reading showed that not all bacterial strains survived digestion
- Strains were studied individually & may perform better when in combination with other strains
- May also get protection from ingredients such as milk protein and lactose

Enhancement of Probiotics

- **Enteric coated**

  These will not be affected in stomach

  The coating will dissolve in intestine

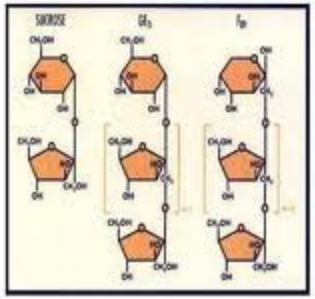
  They will be effective in intestines

- **Prebiotics**

  These are not digested in GI tract

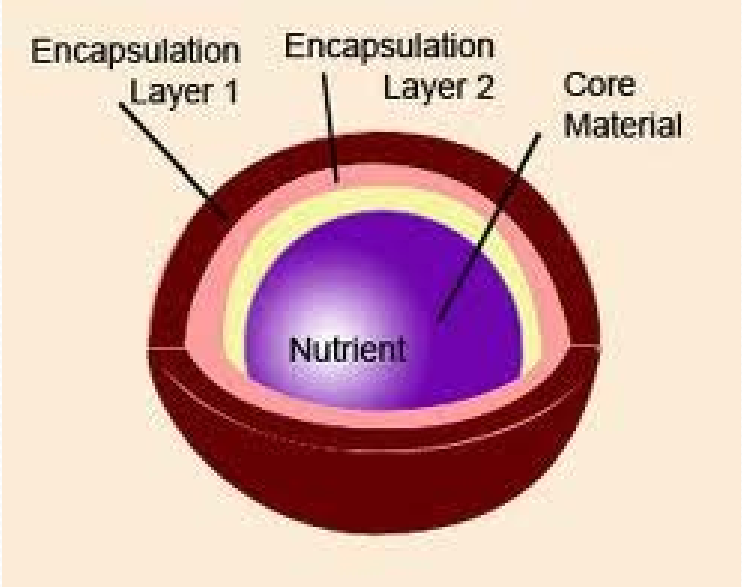
  They provide food for probiotics

  With them the survival of probiotics is better & chances of providing benefits is better



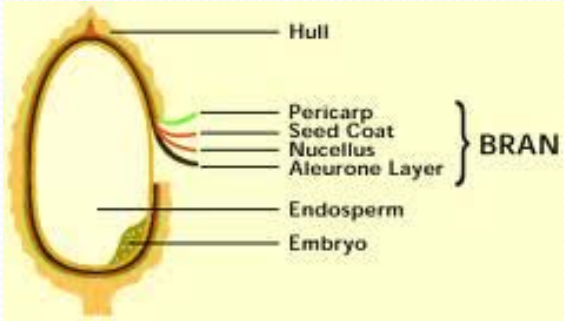
Protecting Antioxidants

- Antioxidants
- Microencapsulation e.g. spray drying
- Enzymic Bioconversion Anthocyanins for Stabilisation



Choosing Process for Better Recovery

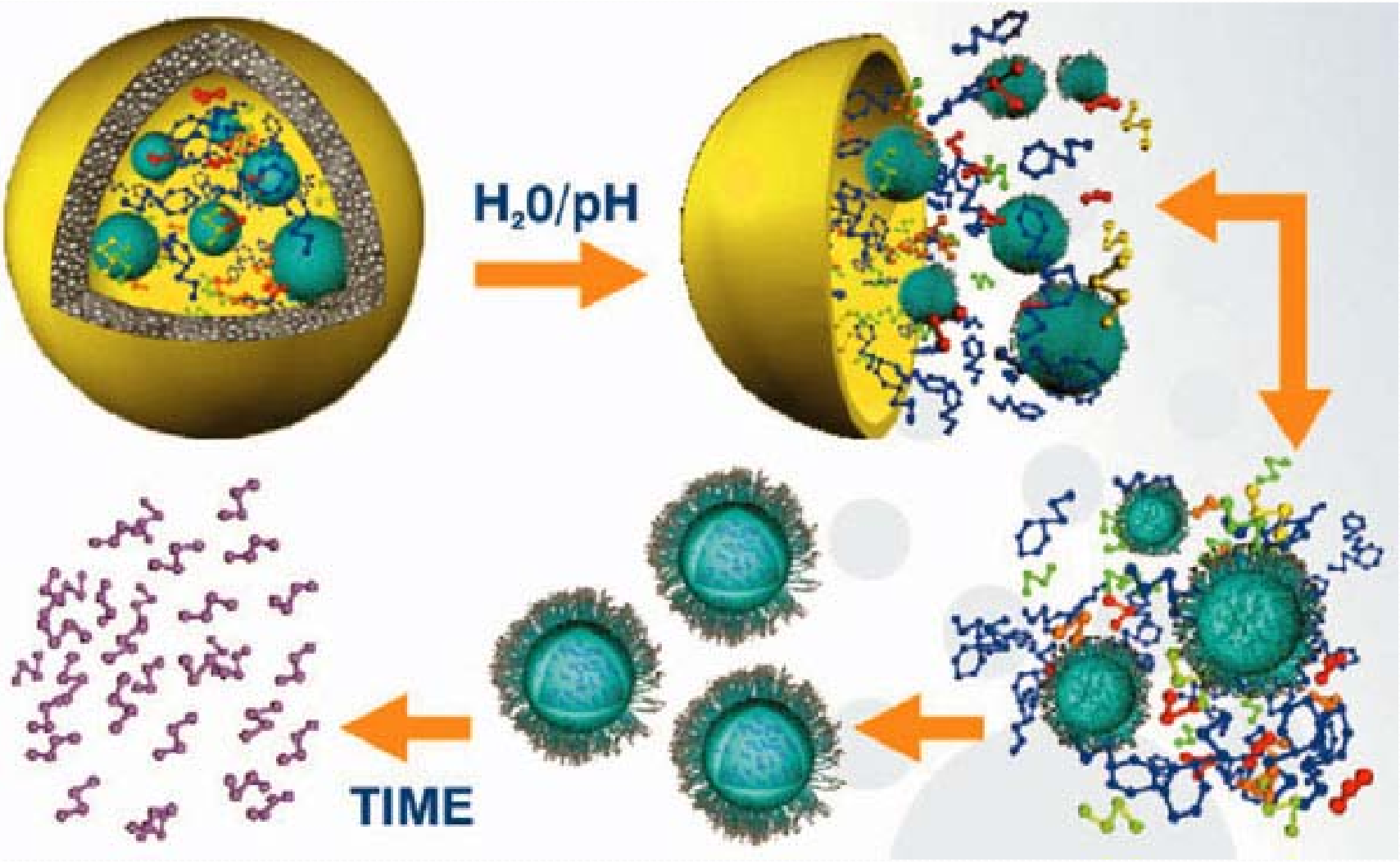
- Oryzanol, minor fraction in rice bran oil unsaponifiables
- Excellent antioxidant
- Beside cancer prevention, protection against heart disease, maintaining cholesterol, diabetic health etc.
- Lost in chemical refining especially alkali treatment
- Physical refining retains much of oryzanol
- Soap stock from chemical refining can be used to recover it for adding to products



Nanotechnology

Agriculture	Food Processing	Food Packaging	Supplements
• Single molecule detection to determine enzyme/ substrate interactions • Nanocapsules for delivery of pesticides, fertilizers and other agrichemicals more efficiently • Delivery of growth hormones in a controlled fashion • Nanosensors for monitoring soil conditions and crop growth • Nanochips for identity preservation and tracking • Nanosensors for detection of animal and plant pathogens • Nanocapsules to deliver vaccines • Nanoparticles to deliver DNA to plants (targeted genetic engineering)	• Nanocapsules to improve bioavailability of neutraceuticals in standard ingredients such as cooking oils • Nanoencapsulated flavor enhancers • Nanotubes and nanoparticles as gelation and viscosifying agents • Nanocapsule infusion of plant based steroids to replace a meat's cholesterol • Nanoparticles to selectively bind and remove chemicals or pathogens from food • Nanoemulsions and –particles for better availability and dispersion of nutrients	• Antibodies attached to fluorescent nanoparticles to detect chemicals or foodborne pathogens • Biodegradable nanosensors for temperature, moisture and time monitoring • Nanoclays and nanofilms as barrier materials to prevent spoilage and prevent oxygen absorption • Electrochemical nano-sensors to detect ethylene • Antimicrobial and antifungal surface coatings with nanoparticles (silver, magnesium, zinc) • Lighter, stronger and more heat-resistant films with silicate nanoparticles • Modified permeation behavior of foils	• Nanosize powders to increase absorption of nutrients • Cellulose nanocrystal composites as drug carrier • Nanoencapsulation of neutraceuticals for better absorption, better stability or targeted delivery • Nanocochleates (coiled nanoparticles) to deliver nutrients more efficiently to cells without affecting color or taste of food • Vitamin sprays dispersing active molecules into nanodroplets for better absorption

Nanospheres



Two or more ingredients that would react with each other if put together can be separated and provided consecutively by placing one in the nanosphere and the other in the microsphere.

Finally

- Potential for use of phytochemicals & other physiologically active substances in foods is tremendous
- Newer technology is available for making safe and effective use to maximise the benefit of functional foods
- Consumer awareness of new technology is essential for its success

Thank You