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*REVIEW PAPER*

# Advances in the Value Addition to Foods - Recent Trends

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**ABSRACT**

Value addition to foods may be done by several ways. It could be done by the use of preservatives, food ingredients capable of eliciting functionalities and by fortification using micronutrients. There are novel and emerging food processing technologies that are possible to preserve the ingredients in the food intact. The shelf life enhancement of the processed food can be done by adapting newer packaging technologies. Food processing industries in many of the countries across the world generates huge quantity of by-products that can be put into use by value addition. These by-products have less use and create considerable environmental pollution. The by-products of the fruits, vegetables, etc. may be used for value addition adapting commercially viable approaches. Fermented foods are value added foods that could be developed using novel starters. It is also important to note the regulatory aspects of foods whenever the foods are preserved by value addition.

**Keywords:** Additives; Ingredients; Advanced technologies; Packaging; Fermentation; By-products utilisation; Food concerns

## 1. INTRODUCTION

Food additives have varied functions. There are emulsifiers that can be used for preventing layer formation in liquid products. Thickeners and stabilisers are used for providing texturising efffects. The use of anticaking agents are meant to give flow of foods freely[1] as in the case of free flowing table salt. Fortification is another method to enrich foods and drinks to provide micronutrients viz. vitamins, minerals, and other nutrients. There are numerous fortified foods in the market, to name a few, flour, cereal, margarine, edible oils, hydrogenated fat, milk, etc. This helps to make up for deficiency of micronutrients in the diet. Microorganisms like bacteria and others can cause food-borne illnesses. Preservatives are employed in food systems that can reduce spoilage. There are anti-oxidants that are synthetic by nature in baked goods and oils to prevent the fats and oils from undergoing oxidation that might otherwise cause off-odour. Potassium metabisulphite, an inorganic compound of chemical formula $Na_2S_2O_5$ is used as a disinfectant, antioxidant and preservative agent. This also keeps fresh fruits from turning brown when they are exposed to the air. Acidulants and other additives help change the acid-base balance of foods to get a certain flavour or colour.

Baked products are porous by nature. Leavening agents cause expansion of doughs and batters resulting in the release of gases within such mixtures, helping to produce porous structure. Some of the examples for leavening agents are air, steam, yeast, baking powder, baking soda, etc. .Such agents that release acids on heating react with baking soda to help rise baked goods and in addition they impart colour and enhanced flavour. Many spices, as well as natural and synthetic flavours, improve the taste of such foods and provide anti-oxidative characteristics. There are concerns about food additives regarding the toxicology when they are added to foods. Some of these are: antibiotic residues in chicken and meat, synthetic antioxidants viz. butylated hydroxyl anisole and butylated hydroxyl toluene in oily or fatty foods, artificial sweeteners, the most important ones being aspartame, saccharine, and sodium cyclamate and benzoates in fruit based products like juices, pickles, squashes, jams and jellies and fishes. Some of the other examples are food stabilisers and emulsifiers like lecithin, gelatins, corn starch, waxes, gums, and propylene glycol, different dyes and colours, monosodium glutamate for providing umami taste in noodles, nitrates and nitrites in preserved and processed meat products and re-structured meat products, sodium metasulphite in beer, wine, and minimally processed fruits and vegetables, etc.

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## 2. VALUE ADDITION BY INGREDIENTS AND MICRONUTRIENTS

Food ingredients have been used for many years for preservation, flavouring, blending, thickening, colouring, and they play vital role in reducing nutritional deficiencies and manifestations among consumers. These food ingredients are also useful to ensure the availability of flavourful, nutritious, safe, shelf-stable, convenient, colourful and affordable foods. Usually all food ingredients and colouring agents are strictly studied and subjected to regulations and monitoring. Federal regulations always demand evidence that each substance is safe to consume with proper toxicological data at its intended level of use before it may be added to foods. Furthermore, all

additives are subject to ongoing safety process and review and at the same time the scientific understanding and methodologies of testing are under continuous improve improvements. It is important about the safety perceptions of the consumer. It is followed that ingredients are useful and provide various functions in a variety of foods. Traditionally we use salt to preserve vegetables, meats and fish, add herbs and spices to improve the flavour of foods and health attributes, preserve fruit with sugar, and pickle cucumbers in a vinegar/saline solution. Consumers want to enjoy food that is tasty, flavourful, nutritious, safe, convenient, colourful, healthy and affordable. There are technological advances that is very much useful to meet their requirements. The Food and Drug Administration (FDA) shows a list of more than 3000 ingredients in its data base that is added to food in the US. Many of them we keep using at our kitchens every day like sugar, baking soda, salt, vinegar, vanilla, yeast, spices and colours[3]. Nevertheless some consumers have concerns about the use of additives regarding its safety. This is because of the unfamiliar names that are used like complex chemical compounds. It is needless to say that every food we eat like picked mango, amla, lemon, pineapple, bitter melon or strawberry or a homemade cookie contain chemical compounds that generates flavour, colour, texture and nutritive value. It is important to note that all food additives and preservatives are very carefully regulated by federal authorities and various international bodies to ensure that foods that we consume are safe to consume and are properly labelled.

It is important to mention about the prevention of the life style diseases by the regular consumption of plant foods. There are several reports in the field of nutrition and health that demonstrates a positive significant link between the regular intake of phyto-compounds and bio-actives in the plant foods viz. polyphenols, carotenoids, phytosterols, ascorbic acid, tocopherlos, plant steroids, phytosterols etc. that are capable of alleviating modern life-style related disorders and diseases. As a natural source of these phytochemicals, especially the consumption of whole foods has been suggested to be of health benefit[4].

Micronutrients like vitamins and minerals have many biological functions. They are involved to synthesise macromolecules or they act as cofactors for essential enzymatic reactions like oxido-reduction reactions and release energy. Micronutrient functions are based on their chemical structure and biochemical properties and are utilised in food science and technology. The purpose of using micronutrients in food industry is to improve the consistency of the food and to provide adequate nutrition and functionalities. In oily foods or fat predominate foods micronutrients are usually used as antioxidants – to prevent oxidative processes leading to impair food quality – and as colouring agents to compensate for colour loss during processing and to impart consumer appealing colours. Food additives have E numbers that is used while labelling. The use of additives in food is only permitted if it is technologically necessary, if they have been investigated and found to be harmless and safe, and have passed inspection by the food safety regulatory authorities. The use of permitted amounts of most food additives are limited. In many of the cases the usual concentration is less than 0.1% of the food to which they are added. The greatest permitted amount is co-determined by the ADI (Acceptable Daily Intake) value of a specific substance[5]. This is the amount that a person could consume every day of their life without damaging their health. The method for ADI shows a graphic presentation of toxicity data and is also shown to be useful for estimating acceptable intakes for durations of toxicant exposure other than the entire lifetime. Another method uses dose-response data to calculate lower concentration levels on the dose rate associated with specified effect levels. Whether or not a substance is regarded as an additive depends on its primary purpose. So if, for instance, micronutrients like vitamins and minerals are used for the purpose of improving the nutritional value of a food, they are considered to be ingredients. However, if they are used to give colour, or for other technological improvements, such as influencing stability or sensory qualities (appearance, aroma, odor an overall acceptability), for example as an antioxidant, they are included among the additives.

## 3. ADVANCED TECHNOLOGIES FOR FOOD PROCESSING

The novel and emerging food processing technologies for value addition are the following: High Pressure Processing for salads and ready meals[7], pulsed electric field processing for liquid foods and beverages[8], high intensity electric field pulses on solid foods[9], enzymatic inactivation by pulsed electric fields[10], etc. are considered to be thermal at the same time the thermal abuse is low. The other non-thermal processing techniques for value addition are osmotic dehydration, a method to increase the shelf life of fresh produce, athermal membrane process like ultra-filtration for the concentration of liquid foods and natural colours, high intensity pulsed light technology ( a rapid and effective low thermal, low energy purification and sterilisation technique), non-thermal processing by radio frequency electric fields (inactivation is dependent on the electric field strength, number of treatment stages, and temperature), application of ultrasound (reproducible food processes can be completed with high reproducibility, reducing the processing cost, simplifying manipulation and work-up, consuming only a fraction of the time and energy normally needed for conventional processes), food irradiation, food preservation using chemical and biochemical hurdles, microwave heating (here microwaves have been employed in a range of food processing methods involving de-hydrating, tempering, blanching with sulphites, cooking, pasteurisation, sterilisation, and baking), radio-frequency processing, ohmic heating, combination of microwave vacuum-drying, new hybrid drying technologies (for heat sensitive food stuffs), NMR technology (a method in which nuclei in a magnetic field take up and re-emit electromagnetic radiation), preservation by vacuum cooling, high pressure freezing (permits the cryo-immobilisation of thick biological specimens up to approx. 500 microns), use of anti-freeze proteins for controlling freezing process (antifreeze proteins also known as ice structuring proteins belong to a class of polypeptides that allow their survival in subzero environments), minimal processing of fresh produce and juices, modified atmosphere packaging (MAP) for minimally processed foods, etc.

## 4. INNOVATIONS IN FOOD PACKING TECHNOLOGIES

The innovations in food packing technologies are: Controlled release solid and liquid packaging, active packaging containing antimicrobial agents for food and beverage, active nanocomposites incorporated food and beverage packaging[11], chitosan coatings that are safe and edible[12], flavour releasing packaging, intelligent packaging and the consumer-packaging interface to improve food safety and quality[13], radio-frequency identification method named as RFID for solid and liquid food packaging applications[14,] safety indicators in food and beverage packaging, tamper-evident food and beverage packaging, light-protective packaging materials for foods and beverages, environmentally compatible food packaging**,** smarter packaging for consumer food waste reduction and bio-based polymers including edible ones in food packaging[15]. Using nanotechnology, micro-film that is developed is described to be thousand times thinner than human hair. This consists solely of water, a soluble polymer and 70% clay particles. It is reported that the packaging is significantly eco-friendly, and possess the preservation qualities of age old glass and could hold the gas in a soda better than anything that is currently available in trade. Advances are also being made to generate an innovative technology like electronic tongue, that can effectively make tasting food through sensors embedded in the food packaging. The packaging will also change colour, if the food is contaminated and not safe to consume.

## 5. COMMERCIALLY VIABLE APPROACHES FOR BY-PRODUCTS UTILISATION

Food processing industries in most of the countries across the world, push huge quantity of by-products of food like pomace, hull, husk, pods, peel, shells, seeds, stems, stalks, bran, washings, pulp refuse, press cakes, etc. These by-products are not put into use and hence create tremendous environmental pollution. There is growing interest in the formulation of health promoting and physiologically active foods and the demand of natural bio-actives available in these by-products are on the increase and it is possible to explore new sources for health promotion[16]. Many of these food industrial by-products are rich sources of dietary fibres and physiologically ingredients viz. carotenoids, poly phenols, etc. These by-products can be modified according to the nature and can be isolated and purified for use in the manufacture of various foods. The suitable products for incorporation of by-products are baked foods, pasta, noodles, ice creams, probiotics like yogurts, cheese, beverages, milk shakes, instant breakfast items like flakes, sports drinks, wine, meat products and meat analogues, synthetic meat-like products, etc.

The livestock industry is growing in India at the rate of 6 per cent per annum. This includes poultry and fish that is increasing substantially in GDP accounting for about >40 per cent of total agricultural sector and >12 per cent of GDP. This contribution does not include animal products. Hence GDP would have been much higher than this value had the animal by-products been also efficiently utilised[17.] Animal by-products can be efficiently utilised and there will be direct impact on the economical state and environmental pollution of the country. This situation not only affect the potential revenues but also lead to disposal cost of these products. It is always important to note that traditions, culture and religion should be taken into consideration when a meat by-product is being utilised for food. There are speculations that meat by-products are used in cosmetics. In that situation we cannot assure that these components are being used for food purpose without the knowledge of regulators and authorities. There are reports that animal by-products are treated and used in pharmaceutical formulations. The use of these by-products in drugs and in food is separate entity. The nutritive value of meat and organ meats is usually higher than that of lean meat issue. Kidney and liver contain $B_2$ which is 5-10 times more than lean meat. Liver is the best source of $B_3$, $B_6$, $B_{12}$, ascorbic acid, vitamin A and of course haematinic iron. Kidney is also a good source of vitamin $B_6$, $B_9$ and $B_{12}$. At the same time regulatory requirements should be kept in mind that many countries restrict the use of meat by-products in food products due to aspects related to safety and quality. The nutritive value of by-products viz. blood, liver, lung, kidney, brains, spleen and tripe should be tapped and can be put into use in the value added marketing system.

It is very important for the efficient waste management of poultry processing and egg production industries and they must be efficiently dealt with as their growth is also important for the economy of the country. Treated fish waste are rich in micronutrients has found many applications in animal feed, biodiesel/biogas, dietetic and nutritive products like chitosan, natural pigments and cosmetics like collagen[17]. Blood being a significant part of the animal's body mass which is around 2.4 % - 8.0 % of the animal's live weight can be separated into several fractions that have therapeutic properties. Blood is also rich in albumin (3.5 per cent), globulin and fibrinogen (4.0 per cent). In the analytical laboratories, many blood products are used as a nutrient for tissue culture media in *in vitro* works, as an important ingredient in blood agar, and as peptones for microbial use. The biochemicals like glycerophosphates, albumins, globulins, sphingomyelins, and oxido-reductive enzymes like catalase, urate oxidase are also used for biological assays. Components like fibrinogen, fibrinolysin, serotonin, kalikreninsa, immunoglobulins and plasminogen are also isolated from blood for various chemical, microbiological and biochemical or medical uses. Animal blood is also used for human consumption after spicing and processing and its high level of protein and heme iron are effectively used. Sausages, blood pudding, biscuits and bread are produced from blood in European countries and it is also extended to use in items such as fertiliser, feedstuffs and binders[18].

## 6. NOVEL STARTERS FOR VALUE ADDED FERMENTED DAIRY PRODUCTS

Fermentation in food is done by the use of certain microorganisms like bacteria, yeasts, and moulds or their combinations and it is essential to have a desired fermentation for the purpose of manufacturing cheese and fermented dairy products. These are known as starter cultures. Products like *dahi, lassi*, yogurt, sour cream, kefir, koumiss, etc. are produced by the fermentation process. Starter cultures are defined as an active microbial preparation, added deliberately

to initiate desirable changes during preparation of fermented products[19]. The lactic acid production by the process of fermentation of lactose is the major role of dairy starters. The resultant acid like lactic acid generated on fermentation is responsible for the development of characteristic body, flavour and texture of the fermented dairy products. In addition it enhances food preservation increasing the shelf stability. A host of functional bio-molecules and food ingredients such as bio-thickeners, bacteriocins like nisin, vitamins especially B vitamins, bioactive peptides and amino acids are generated as a result of fermemntation[19]. Example for bio-thickeners is exopolysaccharides that improve the rheological properties of fermented products. Bacteriocins, one of the examples, nisin, are protein or peptide complexes produced by some bacteria possessing bactericidal or bacteriostatic effect on other species. They are natural, low toxicity and could be digested in body by protease and could be used in food industry

## 7. FOOD SAFETY AND REGULATORY CONCERNS

While animal products are a big concern in terms of food safety, that doesn't mean the plant-derived foods are always safe. In either case, food-borne illnesses can cause vomiting, diarrhea, fever, pain, etc. The infants, pregnant, and elderly are at much higher risk of serious complications resulting death if proper medical attention is not provided. Despite a lot of effort on the part of our government and its employees, thousands of people die every year from food-borne illnesses and more is spent on medical treatment for these problems. The pathogens, or disease-causing agents, that are most commonly responsible for foodborne illnesses are *Campylobacter jejuni,* Norovirus, *Salmonella, E. Coli, Clostridium botulinum, Shigella and Listeria monocytogenes.* Proteins can also cause disease, as per the famous 'mad cow diseases, more technically called bovine spongiform encephalopathy. While government and industry officials do their best to counter the threat of food-borne illness and try to control the amount and type of chemicals being used on our food, there are many reasons why this is not sufficient enough to tackle the situation. We can do this by switching over to organic food where the use of pesticides and antibiotics are nil or limited.

The challenges that are faced in the food safety vary by region. Researchers and industrialists have the great responsibility of providing safe and nutritious food to the people. The current interest in building comprehensive food management systems to ensure the long term involvement and commitment of all concerned is welcome. It is true that biological especially microbiological, chemical and physical food hazards pose significant threat to food safety and the involvement of regulators is very much essential. These issues become formidable challenges for providing safe and nutritious food for the people.

In the global scenario, It will be interesting to note the impact of Food Safety Modernisation Act (FSMA)[20] in the new administration in US**.** It will also be interesting to see if any change is made in the overall direction and function required of FDA**.** With FDA inspectors inspecting facilities to FSMA rules and conducting environmental sampling/swabbing and use of PulseNet, they are likely to discover issues that will bring food safety into question. A key message for 2017 is to make sure that we have done the best we can with our environmental control program, especially if we make ready-to-eat foods[21,22]. Food manufacturers and companies depend on suppliers to provide safe food ingredients both to ensure the end safety of their products and to fulfil FSMA rules. Beyond FSMA, we can also expect to see a continued focus on the regulation/ labelling of GMO foods[23].

## 8. PERSPECTIVE

There is a rapidly growing body of literature covering the role of emerging food processing technologies for value addition and their significant effects on storage and preservation. It is true that consumers are increasingly aware of diet and life-style related health problems that demands safe food ingredients and additives[24]. Food processing industries pose disposal of by-products, at the same time it should be borne in mind that they are also promising sources of useful bio-actives and compounds. Starter cultures have a multifunctional role in dairy fermentations which need to be further explored. PVA nano-composites containing cellulose nano-crystals and silver nano-particles might open up new area in the field of food packaging[25]. A novel packaging technology is developed where in the food can adsorbs $CO_2$ from the atmosphere which is released when the button for activation on pressing. This causes the liquid or beverage present in the can to drop to 30$^o$ F within a matter of few minutes[26]. Much importance is given to regulatory bodies as many countries restrict the use of by-products especially from animal source for reasons of food safety and quality. In this context we can expect to see FDA inspectors facing a continued learning curve as they begin inspections of FDA regulated facilities against the new FSMA regulations.

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**Conflict of Interest:** None.

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