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Exploring the World of Functional Foods: The Rise of Designer Milk and Eggs

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Abstract

The consumption of functional foods has become a significant global trend as individuals seek to enhance their overall health and well-being. Functional foods, defined as foods or food ingredients that offer additional health benefits beyond their traditional nutrients, have gained popularity for their potential to target specific health concerns. This article focuses on two prominent examples of functional foods - designer milk and eggs. Designer milk, exemplified by A2 milk, is a revolutionary concept in the dairy industry, aiming to improve digestion and overall health. Additionally, dairy companies fortify milk with essential nutrients to address nutritional deficiencies. Designer eggs, on the other hand, are enriched with beneficial components like omega-3 fatty acids and essential vitamins through a specialized hen diet. The popularity of designer milk and eggs has soared globally, driven by health-conscious consumers seeking convenient ways to improve their diets. The dairy and poultry industries have responded by catering to this demand, resulting in substantial growth. The creation of functional foods involves extensive research and collaboration among food scientists, nutritionists, and biotechnologists. Regulatory bodies play a critical role in ensuring the safety and efficacy of these products for consumer consumption. As the field of functional foods advances, further innovative products are expected to emerge. However, it is crucial for consumers to make informed choices based on scientific evidence and expert recommendations, while remembering that functional foods are complementary to a balanced diet.

Introduction

Functional food defined as, 'any food of food ingredient that may provide additional health benefits beyond traditional nutrients it contains.' They can also be referred as designer or fortified foods. Functional food incorporates a range of foods and their components which are known to enhance overall health and well-being of human beings. Some common functional foods include designer milk, designer eggs, fortified yoghurt, designer broccoli, functional meat, etc. among these, designer milk and eggs are produced and consumed on large scale all over the world.

Need of functional foods over conventional foods

- It is one of major strategies to reduce micronutrient deficiency in developing countries.
- To reduce dependency on supplements.
- For health implications.
- For processing industries implications.
- An approach to fulfill nutrient requirements of human according to Recommended Dietary Allowances (RDA).
- To minimize incidences of allergies and intolerance.
- Modulation of immune system.

Methods

1. Nutritional approach – by altering what we feed, we get what we want in product (to some extent)
    - Commonly used in layers to alter egg composition
2. Genetic manipulation – by introducing desired genes or knocking out undesired genes
    - Explored in dairy cattle to alter milk constitution

Designer Milk

Milk is considered as natural complete food providing energy, protein, essential vitamins and minerals with appreciable biological value. Designer milk is tailored to consumer's preferences and also has some processing implications. So, it can be classified into two categories-

A. Human health implications

1) Altering fatty acid composition of milk

It can be achieved by targeting enzyme involved in milk fat synthesis in udder, like to reduce acetyl CoA carboxylase. Animals fed diets rich in linoleic acid presented increased levels of conjugated linoleic acid (CLA) in milk fat. CLA are known to have low atherogenicity and thrombogenicity index. Feeding diets rich in unsaturated fatty acids (USFA) such as soybean oil, showed enhanced proportion of USFA to SFA in milk.

2) To make milk suitable forlactose intolerance population

In some people, lactose indigestion had been a serious problem causing impaired digestion of lactose, subsequently diarrhea and osteopenia conditions developed.

Demonstration of transgenic methods resulted in production of low lactose milk by over expression of beta-galactosidase gene in milk. Also, the introduction of lactase enzyme into milk via mammary-gland-specific gene expression had shown enhanced utilization of lactose in human patients. Gene knock-out methodology is also explored to remove alpha-lactalbumin which is

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needed for lactose synthesis in mammary gland.

3) **To reduce incidences of milk allergy**

Bovine-immunoglobulin (b-Ig) is present in cattle milk which is the cause of milk allergy in hypersensitive patients. Some success has been attributed by using gene knock-out technique without affecting other components of milk.

4) **Therapeutic approach**

An anticoagulant named recombinant human antithrombin III has been developed in goat milk using recombinant technology. Also, with the aid of bioengineering, spider genes were introduced into cells of lactating goat which resulted in spider milk. These threads are used for preparing micro-suture materials used in surgical processes.

5) **Humanized bovine milk**

In conditions of unavailability of mother milk, cow's milk is used as substitution for it. But there are variations in both milk. One of these is the low amount (one tenth) of lactoferrin component in bovine milk, known for its natural antimicrobial and immune modulatory properties which are desirable for milk fed child. So, transgenic cows were introduced having lactoferrin gene resulting in lactoferrin secretion in milk.

6) **Alteration in milk protein**

Protein is said to be the building block of body. So adequate protein quantities are advantageous.

In such direction, transgenic cows were developed which secret enhanced levels of beta- and kappa-casein proteins. Also, the amino acid profile of milk can be altered by addition of L-taurine, L-leucine and L-phenlyalanine in diet of cattle.

B. Technological implications

Transgenic cows with elevated levels of kappa-casein protein is linked to small micelle formation, improved heat stability and better cheese making properties. Moreover, the expressionof lysozyme enzyme in milk had shown decreased rennet clotting time and enhanced gel strength in clot.

Designer egg

Egg is one of most commonly consumed food product around the world due to its high nutrient profile, comparatively low cost and said to be one of the highest biological value products. People who show reluctance in consuming meat, prefers egg as a substitute without having hesitation. So, eggs serve as an important food with high quality proteins to large population.

Following are some points regarding altered egg composition.

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1) Alteration in fatty acid composition by feeding marine (salmon, mackerel, etc.) or terrestrial (flaxseed, soybean oil, etc.) omega-3 sources had resulted in desired ratio of omega-3: omega-6 in eggs. The desired ratio had been attributed in improved diseased conditions *viz*. atherosclerosis, arrhythmia, hypertension, bronchial asthma, etc.
2) Layers presented increased CLA concentration in their eggs when are fed on CLA rich diets. CLAs are the important nutritional components having anti-adipogenic, anti-diabetic, anti-carcinogenic, anti-oxidative and anti-inflammatory properties.
3) Egg cholesterol content is naturally very high and reducing such elevated concentration in egg is tedious process. Dietary manipulations had little effect on egg cholesterol amounts however; chromium and copper supplemented diets had shown some benefits.
4) Feeding layer birds with pigment enriched diets like carotene, xanthophylls, lutein from feeds alfalfa, spirulina, marigold petal meal, etc. had presented improved yolk color. These pigments are helpful in prevention of age-related macular degeneration and muscular degeneration. Moreover, deep yellow color is preferred by consumers as it seems to be appealing them.
5) With increased omega-3 concentrations, vitamin E supplementation is also needed in order to prevent per-oxidation of fatty acids. Vitamin E acts as anti-oxidant in body by preventing cells from free radical injuries, generated in every cell during bio-chemical reactions occurring in cytoplasm.
6) Organic Se mineral addition in poultry diet provided positive effects on Se concentration inside egg. Also, significant improvement was observed on egg weight, egg production, feed conversion ratio and albumen quantity. Se in body along with vitamin E, aids in prevention of cells from reactive oxygen species produced from normal cell metabolism.
7) Herbal enriched eggs were obtained by feeding Phyto biotics like garlic, onion, Tulsi leaves, turmeric powder, fenugreek seeds, etc. Phyto biotics contains active principal constituents like polyphenols, cinnamon, camphene, etc. which are beneficial in terms of lowering LDL (low density lipoprotein), immunomodulation, anti-carcinogenic and anti-oxidant properties.
8) Dietary supplementation of herbals like Tulsi leaves in poultry diets was observed with increased number of immunoglobulin-Y antibodies in eggs. These antibodies possess anti-microbial and immune-stimulatory properties.
9) Scientists had explored the property of layers to divert large amount of antibodies into eggs, produced in them when intentionally they were injected with the specific antigen. A large

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array of antibodies can be obtained from layers through eggs which further aids in human health care.

Conclusion

Designer milk and eggs easily merged with the existing system without altering dietary habit of population. They could play a pivotal role in reducing specific nutrient deficiencies in people. They provide a nutrient dens, high quality and inexpensive source of protein with some health and immuno-modulatory advantages. At end, their acceptability depends on animal welfare, product safety, elevated health properties and enhanced economic benefits in comparison to conventional products.

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