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Research Article

Meat Analogue: A Short Review on Processing Aspects

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Abstract

Animal source proteins have been a part of the human diet since long time back. Consumer preferences are seeing a shift from the conventional meat products to the meat analogues based on plant sources. This shift is due to the growing drive for more sustainable and healthier lifestyles, rising health awareness, environmental impact etc. Meat analogues are meat like materials made from plant sources. They have similar texture, flavour, appearances and other nutritional qualities to that of animal meat. Extrusion technology finds its applications in the making of plant-based meat analogues. This paper is focuses on the need for meat analogues and process technology involved for its production.

Keywords: Meat Analogues; Textured Vegetable Protein; Plant Based; Extrusion

Introduction

The title "Meat analogue" suggests that it is not real meat but substitute of animal meat, is usually made from plant based ingredients. They are made of plant based protein sources as main ingredients derived usually from soy bean, pea, wheat gluten, rice, mushrooms, legumes etc. along with other additives like artificial colour and flavours. Meat derived from animal source is considered as one of the good protein sources keeping in mind its nutritional and sensory qualities. Nutritionally meat protein contains all essential amino acids that are required in human body. For food processing, animal meat posses essential properties like gelation, binding and adhesion, emulsification, water holding properties etc. For example, one such animal source protein is gelatin, which is a mixture of peptides and proteins (98-99%), and is considered as novel ingredient with wide ranges of applications in food processing, i.e., desserts, ice cream, yoghurts, dips etc. [1]. Gelatin is a produced by hydrolysis (partial) of collagen, collected from skin, bones and connective tissues of mammalian species like cows, pigs etc. [2].

Meat and meat based products still have a wide global and local markets, because non-vegetarian consumers prefers animal based meat over plant based meat analogues, due to unique textured, flavour profile, juicy and chewy properties of natural animal source meat. Recent consumer's awareness about healthy food consumption, animal rights, price, sustainability and environmental impact has made consumers shift from non-vegetarian to vegetarian diet. Although animal meat is considered as a good source of protein, but it contains saturated fats and other components, which on prolong eating may cause negative health effects. Health conscious consum-

ers prefer balanced vegetarian diets for good and healthy life are choosing meat analogues since it would reduce chances of heart disease, lower blood cholesterol, reducing the risk of cancer and increasing bone mass [1]. For vegetarian and non-vegetarian communities who wants to quit or reduces meat consumption, meat analogue would find its important role. Meat analogues are also called imitation meat, since they imitates the aesthetic qualities of regular animal meat particularly in terms of texture, flavour and appearance. Consumers or the buyers of meat analogue products include vegetarians, vegans, non-vegetarian seeking to reduce or leave meat consumption. Meat analogue became popular recently but similar kinds of products are prepared and available from long back, i.e., yuba-a soy-based meat analogue, textured vegetable protein (TVP). Desirable characteristics of meat analogues are given below [1,3-6]:

- **Role**: To replace conventional animal source meat and meat products
- **Shape**: Sheets, disks, patties, strip etc.
- **Cooking properties**: Ability to retain moisture during cooking
- **Texture**: Striated, layered structure like muscle meat.

Egbert and Borders [5] reported the major challenges in meat analogue lies in the development of acceptable texture and flavour similar to that of the animal meat. Meat analogue market demand is lower than conventional meat [7] since meat analogues lacks sensory profiles as comparable as animal meat sources [8]. For making meat analogue more popular and marketable, food researchers need to work on the sensory aspect as well along with nutritional properties of meat analogues. Beside this, exponential increase in human population, rapid urbanization and industrialization, rise in income and living standards would result in 72% increase meat consumption by the year 2030. From last 10 years, there is 5-13% rise in meat production and soon would reach its highest production capacity, raising concern about food security growing human population. Ethical and environmental violation, (i.e., green house gases generation, like carbon dioxide, methane and nitrous oxide), issues have also come in light resulted by animal harvesting for meat production. Approximately 100 times excess water is essential for animal meat harvesting as compared to food crop cultivation [9]. Keeping all these problems in mind, meat analogue derived from 100% plant-based sources was found to be most suitable solution to address the above-mentioned global food issues. Objective of this article is to make readers aware about meat analogues and its processing aspect.

Manufacturing meat analogues

There is rising demand for plant based proteins as alternative to animal based proteins. Meat analogue structure are affected by protein properties like water holding capacity, oil holding capacity, solubility, emulsification, foaming and other properties. Properties of protein are dependent on kind of protein used. Different protein sources would be having different chemical composition, amino acid profile, structural configuration etc. Beside this, protein structure and functionalities can also be altered by other parameters like pH, temperature, ionic strength etc. [10]. Commonly available meat substitutes are tofu (made from soy beans), tempeh (made from fermented soy derived meat substitute), seitan (made from wheat gluten) etc. For meat analogues preparation, some commonly used non-meat protein sources are mentioned below.

- Soy beans
- Oil seeds (cotton seed, rape seed etc.)
- Wheat
- Rye
- Barley.

Soy bean contains β-conglycinin protein, where as legumes are known for their glycinin and vivilin protein. Oil seeds like rapeseed, cotton seed, peanut etc. contain legumin, albumin, globulin and glutelin. Wheat, rye and barley contain gluten, gliadin and glutenin. Beside this fungus like *Fusarium venenatum* (PTA-2684) can be used for the preparation of meat analogues or texturized vegetable protein. Although several options are there for preparation of meat analogues, however for bulk production, soybean is considered as important ingredient because of its cheaper price [9,11]. Meat analogue preparation involves two main steps as mentioned below [6]:

- **Emulsion preparation:** In this step, all components (i.e., fat, carbohydrate etc.), additives and other ingredients gets encapsulated in the protein matrix, which is further processed.
- **Formation of chunks:** Encapsulated protein emulsion is heated under pressure to denature the protein and chunk formation takes place.

For manufacturing meat analogues, extrusion cooking technology have been used extensively [6,12]. Extrusion cooking is done

with the help of extruder, which contains feeding system, a screw, barrel, die and a cutting mechanism. Preconditioning of raw ingredients before extrusion is desirable and for extrusion processing, the preconditioned materials is fed via feeder. From the feeder, the feed materials are carried by the rotating screw, which mixes, homogenizes and transports the material to the compression section. In compression section, the materials are subjected to higher stress rate, temperature and pressure, resulting in converting the solid into melted flowable material. Hence extrusion cooking basically takes place in three steps, i.e., preconditioning of raw ingredients, mixing/cooking in extrusion chamber and cooling in the die. Careful control of extrusion parameters, like screw speed, moisture content of the feed, temperature of the barrel, feed composition are essential for meat analogue production [10,11]. Redman [13] used extrusion cooking method to manufacture meat analogue containing 40% protein, whose wrinkle skin structure resembles much as cooked muscle meat. Kumar., *et al*. [14] developed meat analogue nuggets by using texturize soy protein, mushroom, wheat gluten etc. and the sensory physico-chemical properties were found much similar to that of cooked chicken nuggets however significant differences were observed in sensorial properties, i.e., flavour, juiciness texture, overall acceptability etc. Hamza., *et al*. [15] used rice flour and faba beans for preparing meat substitutes in beef burger, resulted in improvement of texture and flavour during frozen storage and also reduced production cost. Dekkers., *et al*. [16] reviewed on structural processing involved for meat analogues preparation, where two approaches for preparation of meat analogues were discussed, i.e., bottom-up and top down strategy.

Bottom-up methods of meat analogues manufacturing includes following approaches:

- Application of tissue engineering
- Mycoprotein production from fungus *Fusarium venenatum*
- Wet spinning
- Electro-spinning.

Top-down strategies for meat analogue manufacturing includes following methods:

- Extrusion
- Freeze structuring
- Sheer cell technology.

Out of the two methods, top-down approach was found to be more efficient and easy for up-scaling, whereas bottom-up approach meat analogue structure resembles more like natural meat structure [16].

Additives-Flavours

Kumar., *et al*. (2015) reviewed the work of various researchers who have worked on artificial meaty flavour for meat analogues. Flavours have been identified as important sensory attribute for any food and development of artificial meaty flavour is important aspect for meat analogues. Hashida [17] reported about the usage of chemical condiments like glutamic acid and 5-ribonucleotides for flavour effect applications in vegetable protein based meat analogue products. Hsieh., *et al*. [18] reported about development of synthetic meat flavour by autoclaving simple sugar, amino acids, 5-nucleotides, glycoprotein, monosodium glutamate and salt with fat an optional component. It has been reported that sulphur containing amino acids plays important role in flavour development along with the presence of simple sugars. Spencer., *et al.* [19] patented the composition of 2-(alpha-mercaptoalkyl)-3-thiazoline as flavouring agent which gives a characteristic meaty, sautéed onion flavour and aroma at the level of 0.05-50 PPM in the food products. Golovnya., *et al*. [20] reported their finding on identification of various flavouring from simulated meat flavour compounds using gas chromatography and mass spectrometry. Li and Li [21] reviewed artificial meaty flavour as main factor for consumers acceptance, which is quite complex process that includes analysis and identification of flavour compounds produced in animal meat produces by various chemical reactions such as Maillard reaction, lipid oxidation and thiamine degradation. Meat analogue flavour can be developed by enzymatic hydrolysis of nonmeat protein for developing the precursors of meat flavour, which is followed by oxidation of vegetable oils for simulating the animal lipid like flavouring. Natural spices add on to the flavour and reduce presence of any off-flavours (Li and Li, 2020).

Challenges

Maintaining quality standards is essential since already it has been found by some studies that prepared meat analogues were over-processed, contain high salt content and genetically modified organisms. Animal protein contains all amino acids required for human body, however plant-based proteins quality wise is not as superior as animal protein and also does not contains all essen-

tial amino acids and essential minerals naturally. Taste and texture are considered biggest challenges of meat analogues by the food processors. Animal meat can be directly used for food preparation, unlike plant-based meat which needs to be texturized by extrusion, spinning, and by simple shear flow technique, followed by a thermal treatment to solidify the protein structure. Keeping in mind the complexity of the structure composition, primary meat cuts are not major topics of research, and plant-based meat industries are more focused on production of burger patties, mince and sausages [22].

Conclusion

Plant proteins loaded with phytochemicals and fibres, would be a good alternate of animal source protein, would help to reduce the intake of saturated fats and cholesterol. Protein rich meat analogue would be an inexpensive source of dietetic protein, which can be prepared from low-cost vegetables and legumes although more work needs to be done to meet the quality, nutrition and sensory profile of meat analogues. Concept of easy digestibility of plant based food sources have also been promoted by some researchers compared to animal-based food products. Developed meat analogue would be sufficient to address the nutritional requirement in near future. Novel plant-based meat analogues would have a growing market demand, by overcoming the above discussed huddles. Beside plant based food analogues, the insect-based food products can also be a good protein source, which can be produced with minimal available resources, although other than safety issues, the acceptance towards insect-based meat would be the foremost hurdle.

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