Meat and cheese analogues

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Meat analogous:

A meat analogue, also called meat substitute, mock meat, faux meat, or imitation meat, approximates the aesthetic qualities (primarily texture, flavor, and appearance) and/or chemical characteristics of specific types of meat. Many analogues are soy-based e.g., Tofu, tempeh. Generally, *meat analogue* is understood to mean a food made from non-meats, sometimes without other animal products such as dairy. The market for meat imitations includes vegetarians, vegans, non-vegetarians seeking to reduce their meat consumption for health or ethical reasons, and people following religious dietary laws, such as kashrur or halal. Hindu cuisine features the oldest known use of meat analogues. *Meat analogue* may also refer to a meat-based and/or less-expensive alternative to a particular meat product, such as surimi. Some vegetarian meat analogues are based on centuries-old recipes for seitan (wheat gluten), rice, mushrooms, legumes, tempeh, or pressed-tofu, with flavoring added to make the finished product taste like chicken, beef, lamb, ham, sausage, seafood, etc. yuba is another soy-based meat analogue, made by layering the thin skin which forms on top of boiled soy milk. Some more recent meat analogues include textured vegetable protein (TVP), which is a dry bulk commodity derived from soy, soy concentrate, mycoprotein-based quron which uses egg white as a binder making them unsuitable for vegans, and modified defatted peanut flour. Dairy analogues may be composed of processed rice, soy (tofu, soymilk, soy protein isolate), almond, cashew, gluten (such as with the first non-dairy creamers), nutritional yeast, or a combination of these, as well as flavoring to make it taste like milk, cheeses, yogurt, mayonnaise, ice cream, cream cheese, sour cream, whipped cream, buttermilk, rarebit, or butter. Many dairy analogues contain caesin, which is extracted dried milk proteins, making them unsuitable for vegans. Egg substitutes may be composed of tofu,tapoica starch, or similar products that recreate the leavening and binding effects of eggs in baked goods. Many people use fruit products such as banana paste or applesauce as egg analogues in baking. The extended meat or fabricated meat is popular in the world for economic reasons as well as utilization of other locally available agriculture produce. The extended products provide mixture of proteins and other nutrients to the consumer's, which are desirable from nutrition point of view, and it also satisfies the consumer's desire for meat particularly when they cannot afford the costly meat. This is also an effective way to utilize other agriculture produce. The number of extenders could be very large and it was felt necessary to find an effective method to select functionally compatible ones. Extended meats also in a way solve problems where a part of meat is replaced by other ingredients. Screening of ingredients, one at a time at arbitrary levels may take usually long time as well as the costly resources. In traditional methods of preparation, the difficulty in selecting levels at which to fix the ingredients is also a question to be answered by scientific workers.

Methods of fabricating meat analogues :

Method of preparing meat analogues (Boyer process):

– Preparation of an oil free meal
– Production of washed and dried protein curd
– Preparation of a carefully controlled viscous protein solution
– Extrusion of viscous protein solution through spinneret's into acid coagulating bath
– Collecting and stretching the extruded filaments on reels.

Improved method of manufacturing meat analogs (Westseen and Kuramoto):

– Protein isolate such as soybean in 15 to 30 % solids slurry
– Extrusion spinneret's with 100 to 1600 holes each with diameter 0.002 to 0.006 inches
– Coagulating bath containing 0.5 to 16 % sodium chloride acidified with 0.5 to 10 % lactic, acetic, citric or adipic acid
– Bundles of acid precipitated filaments
– Neutralize with alkali to pH 7
– Impregnate with binders, colors, flavours and other additives
– Stretching and compacting
– Cleaning and neutralizing
– Protein fiber bundles

Cleaning can be accomplished either by vibration method or treatment chamber method

Advantages of meat analogues :

- Versatile
- Convenient
- Equally nutritious to meat
- Calories and fat are completely controlled
- Free from cholesterol or animal fat
- Constancy in flavor, texture and nutrition
- No waste due to physical shrinkage

Commercial meat analogs are produced by the following companies :

- Worthington foods
- General mills
- Archer Daniels Midland
- H.B. Taylor Company
- Swift and Co.
- Ralston Purina

Surimi : Surimi (Japanese, literally "ground meat", Chinese: *yú jiâng*; literally "fish puree or slurry") is a Japanese word referring to a fish-based food product that has been pulverized to a thick paste and has the property of become a dense and rubbery food item when cooked. It is typically made from white-fleshed fish (such as pollock or hake), but the term is also commonly applied to food products made from lean meat prepared in a similar process.

Production: Lean meat from fish or land animals is first separated or minced. The meat then is rinsed numerous times to eliminate undesirable odors. The result is beaten and pulverized to form a gelatinous paste. Depending on the desired texture and flavor of the surimi product, the gelatinous paste is mixed with differing proportions of additives such as starch, egg white, salt, vegetable oil, humectants, sorbitol, sugar, soy protein, seasonings, and enhancers such as transglutaminases and monosodium glutamate (MSG). If the surimi is to be packed and frozen, food-grade cryoprotectants are added as preservatives while the meat paste is being mixed. Under most circumstances, surimi is processed immediately into a formed and cured product.

Cheese analogues: Cheese analogue is a substitute for milk cheese, which is similar in composition, appearance, characteristics and even in its intended use. In cheese analogues, the milk protein and milk fat are partly or wholly replaced by vegetable proteins (*i.e.* peanut protein, soybean protein) and vegetable fats and oils (*i.e.* partly hydrogenated vegetable fat like soybean, palm, etc.). Cheese analogue are formulated and produced with desired nutritional, functional and storage properties as per the market and consumer needs. Cheese substitute can be suitably fabricated to have nutritional benefits. Analogue pizza cheese is manufactured in a manner similar to that for processed cheese manufacture, which finds application in baking as a topping on pizza and as slices in stuffed burgers. The degree of calcium sequestration and para-casein aggregation is controlled by using correct blend of emulsifying salts to give the desired degree of casein hydration/aggregation and fat emulsification in the analogue preparation. Casein-based analogue pizza cheeses were functionally more stable than natural Mozzarella cheese during refrigerated storage with respect to apparent viscosity and free oil. "Sufu" is an example of a soybean based cheese analogue with a spreadable creamy consistency. Cheese substitutes or imitation cheese may be generally defined as the products that are intended to partly or wholly substitute for or imitate cheese and in which milk fat, milk protein or both are partially or wholly replaced by non-milk based alternatives, principally of vegetable origin. A substitute cheese should not be nutritionally inferior to the cheese it is intended to mimic. Rather promoters of imitation cheese claim nutritional advantages compared with genuine cheese *i.e.*, higher unsaturated fatty acids, no cholesterol, less calorie, etc. (Mc Carthy, 1990).

Need for cheese analogues:

The success of any analogue cheese product may be attributed to a number of factors:

– Fast foods and ready-made conventional meals have become extremely popular wherein cheese is used as one of the preferential ingredient.

– Natural cheese costs more than substitutes. The low cost of analogues is due to low cost of vegetable oils compared with butter fat, the low cost of imported casein, relatively low cost of manufacturing equipment compared to that required for natural cheese and the absence of a maturation period for these types of products.

– Cheese substitutes offer diverse functionality range (e.g. flowability, melt resistance, shredability, etc.), which is made possible by tailor-made formulations and they exhibit high functional stability during storage.

– Substitute products can be designed to meet special dietary needs through changes in formulation (e.g. lactose-free, low calorie, low in saturated fat and cholesterol and even vitamin and mineral-enriched).

Classification of cheese analogues:

Imitation/substitute cheese products arbitrarily are classified into three categories: (a) Analogue cheeses, (b) Filled cheeses, and (c) Tofu-based cheeses. Classification may also be based on the ingredients used and the manufacturing procedures followed. Cheese analogues may also be categorized as dairy, partial dairy or non dairy ones, depending upon whether the fat and or protein components are from dairy or vegetable sources as shown

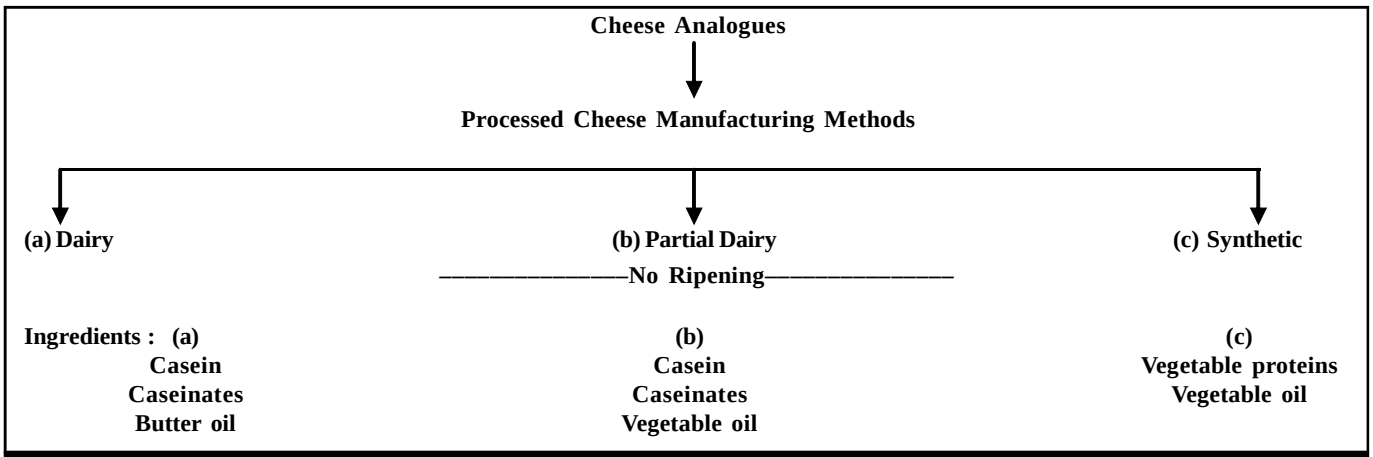

Fig. 1 : Cheese analogues

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Filled cheeses generally differ from the natural cheeses in that milk fat is partly or fully replaced by vegetable oils, which in turn could be partially hydrogenated to impart eating profile similar to that of milk fat. Moreover, filled cheese may be made in two ways: (a) using liquid milk, usually skimmed milk plus vegetable oil, or (b) totally synthetic (using vegetable proteins as well). Both involve conventional in-vat cheese making methods. Ghosh and Kulkarni (1996) prepared low cholesterol filled Mozzarella cheese using sunflower oil. Reconstitution of the dried milk to a higher than normal solids content improved the quality of filled cheese (Mohamed, 1980). "Stirred curd cheese" has been manufactured from filled milks containing soy bean oil, coconut oil and admixtures of both, however, the

Table 1 : Ingredients used in manufacture of cheese analogues

Sr. No.	Ingredient	Main function / Effect	Examples
1.	Fat	Gives desirable composition, texture and meltability, butter oils imparts dairy flavour.	Butter, Anhydrous Milk Fat, hydrogenated soybean oil, corn oil, palm kernel oil etc.
2.	Milk Proteins	Semi hard texture with good shreadibility, flow and stretch characteristics.	Casein, caseinates and whey protein.
3.	Vegetable oil	Gives desired composition and cost reduction	Soybean and peanut protein and wheat gluten.
4.	Sterches	Substitution for casein and cost reduction.	Native and modified forms of maize and rice, potato starches.
5.	Stabilisers		
	Emusifying salts	Assist in the formation of physico chemical stable product, modified textural and functional properties	Sodium phosphate and sodium citrate.
	Hydrocolloids carrageenan	Enhances Product Stability	Guar gum, xanthan gum, carrageenan
6.	Acidifying agents	Asssit control of pH in final product	Organic acids (Lactic, acetic and phosphoric acid)
7.	Flavours and flavour enhancers	Imparts and accentuates flavor	Enzyme Modified Cheese, Starter distillates, wood smoke extracts, spices, sodium chloriode and yeast extract.
8.	Colours	Imparts desired colour	Annatto, Paprika, Artificial colours.
9.	Preservatives	Prolongs shelf life and controls microbial growth	Nisin, K- sorbate, Calcium and sodium propionate
10.	Mineralised Vitamin Preparations	Improved Nutritive Value	Magnesium oxide, Zinc Oxide, iron, vitamin A, folic acid and thiamine.

flavour and body and texture characteristics differed somewhat from conventional cheese (milk based). There are few, if any, standards relating to permitted ingredients or manufacturing procedures for imitation cheese products.

Variants of cheese analogues and their applications: Analogue cheeses were introduced in the US in early 1970's. Cheese alternatives are being produced and sold in USA, UK, Sweden, France, Germany, Belgium, Switzerland and Australia. The annual production of Mozzarella cheese analogue (MCA) was estimated at 80,000 metric tones, which exceeded 20% of the total quantity of Italian type cheese produced in the US. The market share of imitation cheese had stabilized at about 7 % in the US and about 3% in Europe (Mc Carthy, 1990). About 60% of cheese substitutes are utilized in pizzas.The manufacture of analogues of a wide variety of natural cheeses (e.g. Cheddar, Monterey Jack, Mozzarella, Parmesan, Romano, Blue and Cream) and pasteurized cheese products has been reported. The majorities of such products are substitute for or imitations of low-moisture Mozzarella, Cheddar and pasteurized processed Cheddar.These products find application mainly on cheese toppings for frozen pizza pie and slices in stuffed burgers. Other applications include use in salads, sandwiches, spaghetti sprinkling, cheese sauces, cheese dips and ready-made meals. Formulation for cheese analogues The major protein source in dairy-based Analogue Cheese Products (ACPs) is caseinate or rennet casein, with the former being used mainly for spreadable products. Rennet casein is favored for semi-hard block products and especially for APC where it generally imparts better stringiness and stretchability than acid casein or Na- or Ca-caseinates. By choosing the appropriate blend of emulsifying salts, the concentration of calcium cross-linking the paracasein molecules can be reduced to the desired level to render textural and cooking characteristic 'tailor made' to suit the envisaged application of the product. An array of ingredients is used in the manufacture of cheese analogues as depicted in Table 1. The health attributes of imitation cheese could be improved by adding nutritionally beneficial

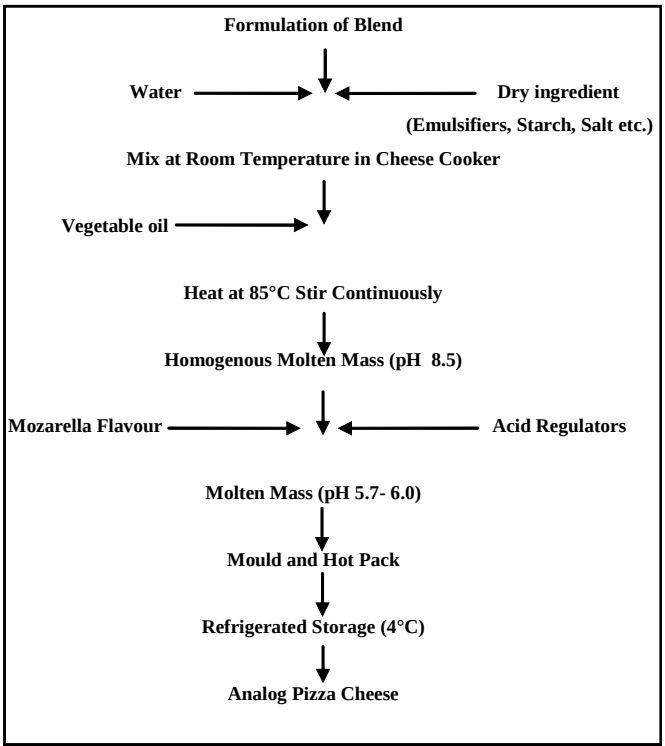

Fig. 2 : Flow diagram for manufacturing processes of cheese analogs

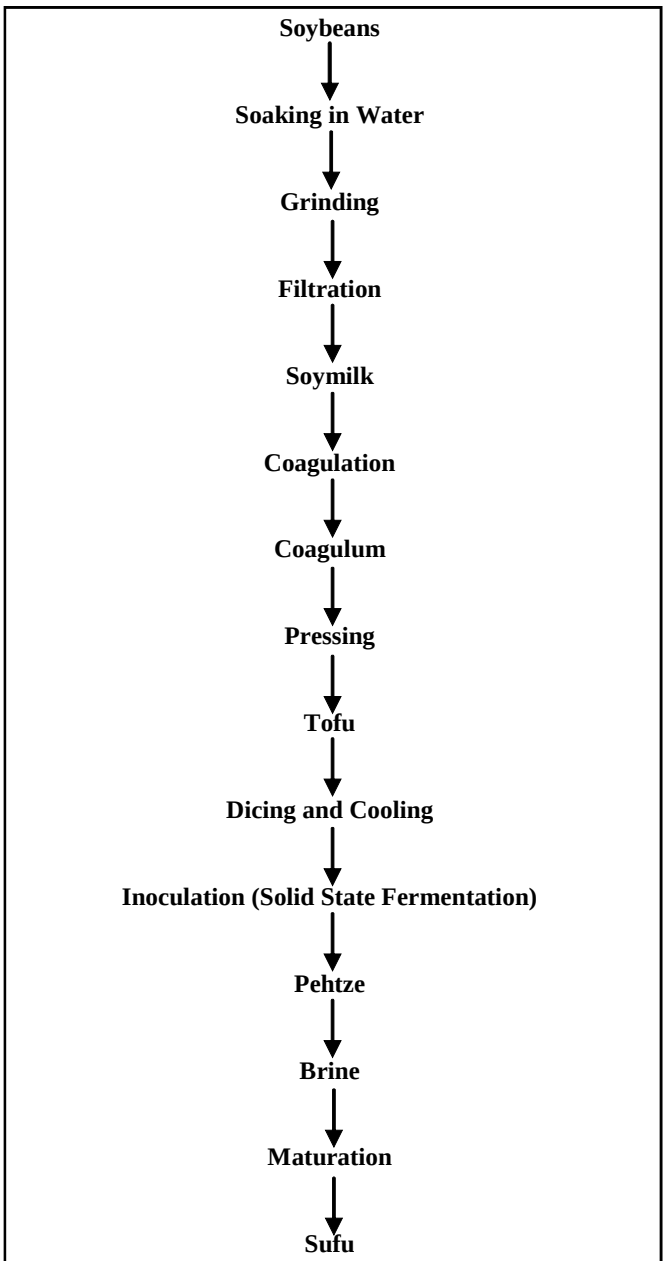

Fig. 3 : Schematic diagram for production of *sofu*

ingredients such as fibre and by lowering the fat content. Resistant starch, a source of fibre, is widely used in the manufacture of imitation cheese (Phillips *et al.*, 1995). Hoffman *et al.* (2005) reported that the use of tri-calcium phosphate as an emulsifying salt, at incremental levels of addition in manufacturing of "low-fat Mozzarella analogue" from acid casein resulted in decrease in cohesiveness, hardness and gumminess of the resultant product. There was no noticeable difference between cheeses analogues containing acid casein and rennet casein when observed through electron microscopy.

Manufacturing technique of cheese analogue: A typical manufacturing procedure involves the following steps: simultaneous addition of required quantities of water and dry ingredients (e.g. casein, emulsifying salts), addition of oil and cooking to about 85^0C (using direct steam injection), while continuously shearing until a uniform homogenous, molten mass is obtained. The flavouring materials (e.g. enzyme modified cheese (EMC), starter distillate) and pH regulator (e.g. citric acid) are then added and the mixture is blended for further few minutes and then hot-packed. Horizontal twin-screw cookers (e.g. Damrow, Blentech), operating at a typical screw speed of about 40 rpm are used in the manufacture of APC (Guinee *et al*., 2004). Addition of the acid at the end of manufacture, ensures a high pH (8-9) in the blend during processing which helps in greater sequestration of calcium by the emulsifying salt (*i.e.* sodium phosphate) during processing, higher negative charge on the casein and higher degree of para-casein hydration. All of these lead to better emulsification of vegetable oil in the protein matrix. The addition of flavoring ingredients, such as EMC towards the end of processing, minimizes the loss of flavor volatiles at the high temperature of processing.

The varieties of cheese substitutes which are commonly available in the market are those of Mozzarella, Process American, Provolone, Parmesan, Process cheese food and cheese spread substitutes. In addition, fabricated cheese substitutes offering dietary benefits such as those with polyunsaturated fats and lower calories are also available. Thus, the dairy industry can now produce 'tailor-made' cheese analogues as per the specifications of the user at a price competitive to the natural counterpart. The largest user of cheese substitutes is the pizza industry and the formulated and processed foods industry. Pizza manufacturers are increasingly using Mozzarella cheese substitutes, tempted by the economic advantages, the physical and microbiological quality, the performance and the storage stability of the substitutes. Cheese substitutes in slices, as shreds and in the other innovative forms will be introduced in the time to come.

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