زانکۆی سەلاحەدین-هەولێر
Salahaddin University-Erbil

NOVEL STRATEGIES TOWARDS HEALTHIER MEAT PRODUCTS AS FUNCTIONAL FOOD

Research project

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By:

Dilma Salh

Supervised by:

Dr. Salih Mustafa Salih

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1. ABSTRACT

Meat and meat products contain essential components of the diet, providing many nutrients such as protein of high biological value, fat, mineral, vitamins and antioxidants. However, its excessive consumption in particular with processed meat products has been linked to some negative health consequences due to some of its components such as high level of saturated fatty acid, added salt and some additives that increase the risk of some diseases.

On the other hand, meat and processed meat products are lack of dietary fibres that are essential in our daily diet, and according to several researches, our daily consumption of dietary fibres is not sufficient for most of the population.

Therefore, meat and processed meat products can be modified by adding or replacing some ingredients especially fat with some functional ingredients such as dietary fibre, herbs, spices and many other functional ingredients that are considered beneficial for human health.

The use of these functional ingredients in processed meat products offers the opportunity to improve the nutritional and health qualities of the processed meat products such as salami, hot dogs, sausages, burgers and so on.

This review project aims to highlighted some of the findings on the published articles in recent years regarding the using of some functional ingredients in processed meat products.

2. INTRODUCTION

Meat and meat products are very popular foods and widely accepted by consumers. However, the global production and consumption dynamics of meat and meat products have changed rapidly as the result of changing lifestyles and nutritional ideologies among part of the population. As a result, it is important to address several different aspects regarding the quality of meat and meat products, particularly those having to do with nutrition, safety and sustainability. Meat and meat products contain essential components such as protein of high biological value, fat, mineral vitamins with high bioavailability, etc. However, the excessive consumption has been linked to some negative health consequences due to some of its components such as lipids, salt, additives, and others (Ruiz and Herrero, 2021). For example, intake of sodium chloride, which is added in most processed meat products has been linked to hypertension (Arihara, 2006).

Consumers now view meat products as less healthy and less attractive, and this makes them more selective in the products they consume, as they are increasingly aware of improving their health through the foods they consume (Ruiz and Herrero, 2021).

The nutritional value of meat depends on the percentage content, fat, protein, essential unsaturated fatty acids, minerals, vitamins and the ratio of fatty acids from the group n-3 to n-6. The increase in consumer requirements in Europe and the change in lifestyle over the last 10 years have affected the international meat market. Consumers began to require high standards of quality and safety of products (Salminen *et al* 2007).

In order to give the meat product, the nature of healthy food, which can meet the expectations of consumers, processed meat products should be fortified with desirable ingredients such dietary fiber and reduce the content of undesirable compound such as fat, salts and nitrates. The (Arihara, 2006).

Jiménez-Colmenero (2001) suggested list of strategies for developing healthier meat products as functional meat as below:

1. Modification of carcass composition.

2. Manipulation of meat raw materials.

3. Reformulation of meat products:

– Reduction of fat content.

– Modification of the fatty acid profile.

– Reduction of cholesterol.

– Reduction of calories.

– Reduction of sodium content.

– Reduction of nitrites.

– Incorporation of functional ingredients.

3. Justification of this project review

Due to the recent changes on life style and food habit, obesity and diet related diseases were increased. This is mainly due to unhealthy eating food and sedentary life style.

Meat products in general are considered a good source of protein and several minerals and vitamins. However, meat and meat products are low in fibre and processed meat in particular are high in salt and fat content. High fat and salt content were associated with several cardiovascular diseases.

Therefore, novel strategies toward healthier processed meat products are in demand.

In this project, we are aiming to collecting information on the papers reviewed the most alternative functional ingredients and fibre supplements added to meat product as fat replacement and reduce salt content, as well as increase fibre content.

4. Objectives:

- To examine the effectiveness of using different functional ingredients as alternative and replacement to fat content.
- To assess whether the quality properties of functional meat is maintained.
- To find out which of the functional ingredients added to the meat products are most preferred by the panellists/ consumers.

5. LITERATURE REVIEW

The purpose of the current literature review was to give an overview of the existing research work on meat production, processed meat and it is association with health side effects, and the opportunities towards healthier meat products and functional ingredients added.

5.1 Meat Production and Consumption

Food is one of the most basic needs for human life (Axelson, 1986, WHO, 2013). Animal products are among the main food items for agribusiness chains (Speedy, 2003), and an important source of many essential nutrients such as protein, fats, minerals, vitamins (Weiss et al., 2010).

Meat products are well known of major sources of protein (Biesalski, 2005). The production of foods from animal sources is in increasing due to growing demand. The global production and consumption of meat is expected to continue to rise, from 233 million metric tons (Mt) in 2000 to 300 million Mt in 2020. However, the pattern of consumption is varied; the annual consumption of meat in the U.S. is 124kg per capita compared to the global average of 38kg (Speedy, 2003).

This difference is mostly due to cultural and religious factors (Allievi et al., 2015). Increasing meat consumption, especially in the western world (Rohrmann et al., 2013), is due to many factors such as wealth, volume of livestock production and socio-economic status of the consumers. The consumption pattern also varies by gender, with men more likely to eat meat than women in European countries (Figure 1.1).

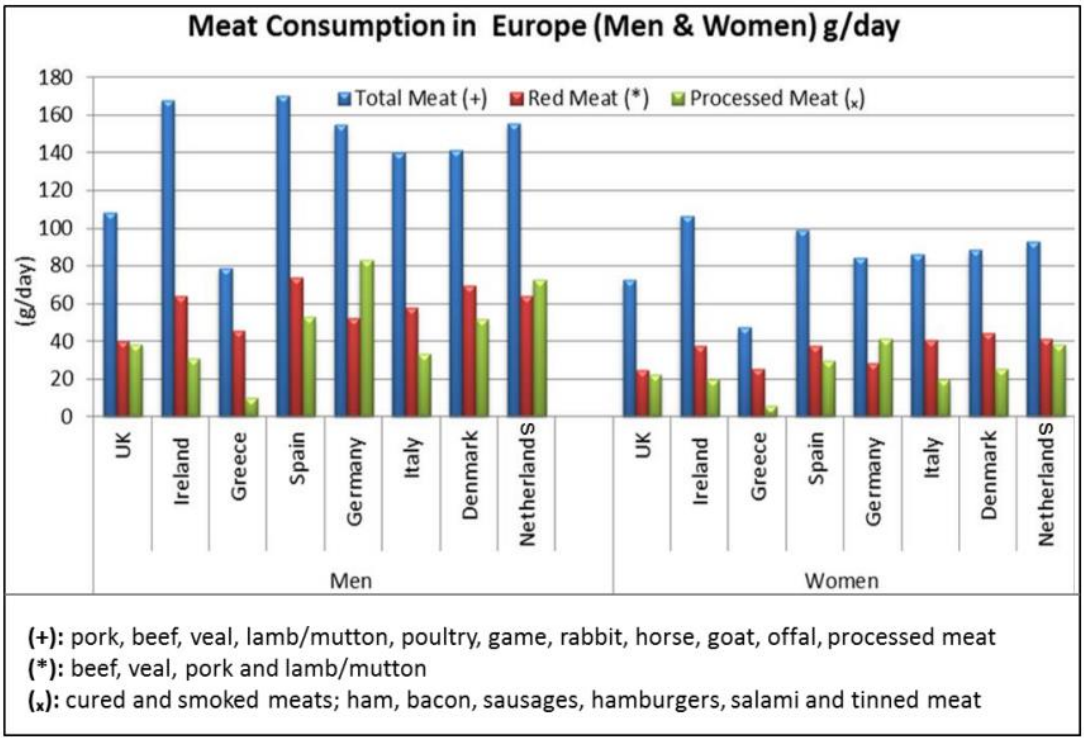

Figure 1.1: Daily intakes of meat consumption in the Europe, adapted from McAfee *et al.* (2010)

5.2 Health Benefit Meat

Improvements in the quality image of meat products are needed to meet consumer satisfaction. Meat and meat products are considered to be of high nutritional and biological value including protein, valuable amounts of fatty acids, vitamins, minerals and other bioactive compounds (López-López et al., 2010).

Foods of animal origin including meat are required to maintain the health of a human body. Meat is specifically valuable as a source of omega-3 fatty acids, vitamin B12, protein and highly bioavailable iron (Majeed et al., 2024).

5.3 Processed Meat

Processed meat products are commonly high in fat and salt (Biesalski, 2005, Weiss et al., 2010), and the link between excessive consumption of meat products rich in fats and some chronic diseases was highlighted in several epidemiology studies (Arihara, 2006; Käferstein and Clugston, 1995).

Consumers believe that food should contribute directly to their health, and not only should it satisfy hunger and provide necessary nutrients, but it should also prevent nutrition related diseases (Roberfroid, 2000, Menrad, 2003). This can be achieved with modification of normal components by the substitution of detrimental components with functional ingredients that are considered beneficial for health (Fernandez-Gines et al., 2005).

The negative image of frequently consuming meat is due to high fat content (Biesalski, 2005), especially processed meat products from takeaway or fast food outlets (Jaworowska et al., 2013). Meat products such as sausages, burgers, pork pies and kebabs account for almost half of all meat consumed in developed countries (Kearney, 2010). Low meat intake, in particular red meat, is recommended to avoid harmful health effects (Biesalski, 2005).

Meat products' consumption has been associated unreasonably, with several adverse health consequences: high levels of salt and nitrites, some fibers (Teixeira and Rodrigues, 2021).

However, in spite of all the positive attributes, meats are deficient in essential dietary fibre (Papadima and Bloukas, 1999, Mehta et al., 2015). Meat products are also recognized for having high fat content (Papadima and Bloukas, 1999, Biesalski, 2005, Tomaschunas et al., 2013), especially those products from takeaway or fast food outlets (Papadima and Bloukas, 1999, Jaworowska et al., 2013), including sausages, burgers, pork pies, and kebabs, which account for almost half of all meat consumed in developed countries (Kearney, 2010).

5.4 TOWARD HEALTHIER MEAT

Consumer perceptions towards healthier meat products are now mainly linked with how meat is produced and processed; the physical and chemical composition; nutritional quality; sensory characteristics, and social, ethic, or religious aspects (Teixeira and Rodrigues, 2021).

Recent innovations in the meat industry are addressed towards the production of healthier meats and processed meats. The strategies are based on either reducing the content of unhealthy

substances (i.e. less added sodium chloride, less nitrate and nitrite) or improving the content of substances with healthy benefits (i.e. natural antioxidants, omega-3 fatty acids, probiotics and bioactive peptides) (Toldrá, et al., 2011).

Value improvement can be realized by adding functional compounds including conjugated linoneleic acid, vitamin E, n3 fatty acids and selenium in animal diets to improve animal production, carcass composition and fresh meat quality. In addition, functional ingredients such as vegetable proteins, dietary fibers, herbs and spices, and lactic acid bacteria can be directly incorporated into meat products during processing to improve their functional value for consumers (Zhang, et al., 2010).

However, epidemiological research has demonstrated the relationship between excessive consumption of diets rich in fats and the emergence of chronic diseases (Käferstein and Clugston, 1995, Micha et al., 2010, Bhat and Bhat, 2011). These increasing concerns have driven the food industry to develop new formulations or modify traditional products to make them healthier (Garcıa et al., 2002).

Therefore, the reduction or removal of fat from meat products is desirable, but challenging (Tomaschunas et al., 2013, Keenan et al., 2014), as there are many problems concerning their acceptance (Sandrou and Arvanitoyannis, 2000, Tomaschunas et al., 2013), including the difficulties in maintaining attributes such as appearance, flavour, and texture (Tomaschunas et al., 2013). As a result of reducing fat, the products become firmer, more rubbery, less juicy, darker in colour and less acceptable (Keeton, 1994, Mallika et al., 2009).

Table 1: Formulations changes to reduce the use of nitrites in meat products and their health technological advances and sensory implications.

Meat product	**Formulation changes**	**Health technological advances**	**Sensory implications**	**References**
'Sucuk' a Turkish fermented beef sausage	Use of beetroot powder as nitrite alternative	Increasing the a* outcome in a desired red color during storage	Sensory evaluation scores of samples with beet root powder were comparable to those of control with nitrite	(Sucu and Turp, 2018)
Sausages	Natural curing agents as nitrite alternative	Protection from quality deterioration during storage. To ensure microbiological safety. The effectiveness of Celery powder as alternative to nitrite	Sausages treated with paprika powder and blueberry powder were the best evaluated	(Jin at el., 2018)
Fermented cooked sausages	Use of chitosan and radish powder to replace synthetic nitrite	Improve the microbiological stability	Overall acceptability was influenced	(Ozaki et al., 2020)
Frankfurter type sausages	e-polylysine (e-PL) or e-polylysine nanoparticle (e-PLN) combined with plants extracts	Improve shelf life	Sausages formulated with e-PLN had higher sensory properties	(Alirezalu et al.,2021)
Beef burger	Use of quinoa and buckwheat flour in a functional formulation to replace soy protein and bread crumb	New meat products with pseudo-cereals with high quality plant protein and improved shelf life	Burgers with quinoa and buckwheat flours had higher sensory acceptance than burger with soy protein	(Bahmanyar et al., 2021)

Table 2: Use of fat alternatives to improve meat products healthiness and their nutritional, technological and sensory implications

Meat product	Formulation changes	Nutritional and technological benefits	Sensory implications	References
Frankfurters	Emulsion gels based on soy oil as pork backfat replacers	No differences in texture, rheology, and technological properties Improved nutritional properties	Reformulated frankfurters had lower acceptability than- control	(Paglarini et al.,2019)
Salt reduced Bologna sausage	Emulsion gel containing inulin, soy protein isolate and soybean oil as animal fat replacers	Healthier fatty acids composition	Sensory acceptable scores Flavor and aroma were reduced	(Paglarini et al.,2020)
Hot-dog style sausages	Pork skin-based emulsion gels with canola oil, bamboo fiber and inulin as pork backfat replacers	Physicochemical parameters not affectedv3-PUFA and dietary fiber contents improved SFAs and v6/v3 ratio decreased Different physicochemical parameters	Sensory parameters not changed	(Santos etal., 2020)
Dry fermented sausages	Inulin gelled suspension and inulin linseed oil gelled emulsion as pork backfat replacer	Total [35] fat and SFA reduced, and v6/v3 ratio was more favourable Higher susceptibility to oxidation and ipolysis	Inulin suspension sausages had the highest overall acceptability Inulin oil emulsion had the lowest sensory scores	(Glisic et al., 2019)
Beef burgers	Tiger nut oil emulsion as animal (beef) fat replacer	Reduced total and saturated fat content, increased unsaturated fatty acids	Beef fat substitution had no influence in sensory parameters acceptability Sensory differences in texture were detected with olive oil	(Barros et al., 2020)
Cooked lamb sausages	Vegetable oils (chia, linseed, olive oil) as pork backfat replacers	Nutritional indexes improved Linseed enhanced the lipid profile without changes in technological characteristics	Linseed did not change sensory characteristics	(Carvalho et al., 2020)
Burgers	Hydrogelled emulsion from chia and linseed oils to replace pork backfat	Technological properties not adversely affected Healthier lipid profile No differences in technological properties and good oxidative stability after 30 days of storage	Possibility of 60% pork backfat replacement with good acceptability	(Heck et al.,2019)
Dry fermented sausages	Mixture of olive and chia oil structured in oleogel or emulsion gel as animal fat replacer	Improved fatty acid profil Decrease of v6/v3 ratio PUFA	Lower acceptability scores were attributed to sausages with fat replacer	(Pintado et al., 2020)

5.5 FUNCTION INGREDIENTS

The concept of functional food was first promoted in 1984 by Japanese scientists who studied the relationships between nutrition, sensory satisfaction, fortification and modulation of physiological systems. Several functional ingredients have been used for these purposes in the food industry. For instance, soy protein has been widely used in meat, poultry and seafood products and commercial inulin from chicory in several meat products (Mehta et al., 2015).

However, the challenge for both the scientific community and the food industries is to give consumers the assurance that these new food products are not a new opportunity for profits that may mislead consumers, but a genuine attempt toward better and healthier food (Roberfroid, 1999). Some of those ingredients are explained below:

5.5.1 Dietary fibre

Dietary fiber can be classified as soluble and insoluble fiber. Both types of fiber have numerous health benefits including maintaining bowel integrity and health**,** lowering blood cholesterol levels, controlling blood sugar levels and providing a non-caloric bulking agent that can aid in weight loss by replacing caloric food components such as fat. dietary fibers are under consumed by most adults indicating that fiber fortification is needed (Decker and Park, 2010).

Dietary fibres are a part to the broad category of carbohydrates that are classified into soluble and fermentable, such as inulin, and insoluble and non-fermentable, such as cellulose. Generally, dietary fibres are incorporated into meat products as a fat substitution as one of the most dynamically developing branches of the production of low-calorie foodstuffs. This is due to its water retention property, improved cooking yield and neutral flavour. In addition, it has health benefits and increases the bulk of the product (Biswas et al., 2011).

For example, inulin as dietary fibre is legally classified as food or food ingredients, not as additives in European countries, as well as Generally Recognized as Safe status in the U.S. (Barclay et al., 2010). Several study have been successfully used dietary fibre as functional ingredients into meat products (Salih, 2017).

5.5.2 Minerals

Dietary mineral is essential for bone health, hypertension, muscle and nerve function, regulation of blood sugar levels and thus are important in diseases such as hypertension, cardiovascular disease, osteoporosis and diabetes (Decker and Park, 2010).

5.5.3 Antioxidant vitamins

Dietary antioxidants have been suggested to be beneficial to immune function, heart disease and cancer. Vitamins A, C and E are consumed at levels below their recommended dietary intake levels by many consumers (Decker and Park, 2010).

6. CONCLUSION

The nutritional composition of meat products can be altered by direct addition of bioactive food ingredients or by the inclusion of bioactive compounds into animal diets. The latter technique has the advantage that the bioactive compounds would be biologically introduced into the food and thus would not have to be declared as a food additive. This is important since food additives are often not allowed in meats.

Furthermore, several dietary fibre and other functional ingredients are demonstrated for their healthier benefit and maintained meat quality and sensory attribute when they are incorporated in processed meat products.

However, further studies are required to demonstrate the clear benefits of these functional compounds when they are added into meat products and well as efforts should also be directed to ensure that new functional meat products are safe for consumption and poses no health effects.

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