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COMPILATION OF SUPPORTING DATA ON REDUCING SALT (NaCl) FOR HEALTHIER MEAT AND MEAT PRODUCTS: A REVIEW

Theodora Ojangba[1], Li Zhang[2], Zhuo Wang[3]

[1,2,3] College of Food Science and Engineering, Gansu Agricultural University, Lanzhou 730073, China
[1]Department of Food Science and Technology, University for Development Studies, Tamale, Ghana

Abstract

Sodium chloride (NaCl), known locally as table salt is the primary sodium intake source in today's human diet. Excessive sodium consumption is related to cardiovascular diseases (CVDs), especially hypertension. Meat and meat products have unlimited quantities of sodium that exceeds the recommended intake (5 g of sodium chloride containing 2 g of sodium) by the World Health Organization (WHO). Although efforts are made to reduce salt consumption, the underlying mechanisms still pose challenges to several meat industries and consumers to comply with the regulations. The current review highlights detailed supporting data on how salt can be reduced by substitution with other substances as a remedy for cardiovascular diseases. Feasible alternatives for reducing sodium content are simply reducing NaCl input in products and substituting with non-chloride salts such as phosphate and/or using chloride salts such as potassium chloride (KCl), calcium chloride (CaCl2) and magnesium chloride (MgCl2), suitable plant extracts, flavor compounds and using advanced technologies.

Keyword: Sodium chloride, potassium chloride, reduction, high pressure processing (HPP)

1.INTRODUCTION

Salt is a food grade additive that acts on food substances to bring the functionality of the product in terms of taste. Scientifically, in modifying and monitoring the texture of processed meat products, salt plays a key role by enhancing meat proteins, leading to higher water holding ability and protein binding properties, thereby improving the texture and flavor of food stuffs (Cluff et al., 2017; Desmond, 2006; Marchetti et al., 2015; Pighin et al., 2008). Salt is often used in meat processing for different purposes, including preservation, flavor development and functional behavior(Mejia et al., 2019). According to Dos Santos et al. (2015) , products made with salt are easier to slice. Among the various salts available, sodium chloride (NaCl) is the predominant sodium source in the human diet today as stated by Paulsen et al. (2014) and is identified as one of the key sources of dietary sodium in meat products (Dos Santos et al., 2015). Excessive consumption of sodium has been related to elevated blood pressure, resulting in elevated risk of cardiovascular disease (Capuano et al., 2013; Webster et al., 2010). Consequently, several efforts and research are being made to minimize salt intake as it contributes much of the sodium in diets. Recent recommendation by the Organization (2016) indicated that, salt can become harmful when consumed in amounts which exceed the recommended daily intake of 5 g/day, equivalent to 2 g/day of sodium. Word Health Organization (WHO) recommendation to consume just 2 g per day of sodium has become a huge challenge for both the meat sector and customers. Vidal et al. (2020) demonstrated that, there are numerous ways for limiting sodium in meat and congener foods simply by decreasing the use of sodium chloride (NaCl) and substituting with other chlorinated salts such as KCl, CaCl2 (Vidal, Biachi, et al., 2019) and MgCl2 Domínguez et al. (2019), non-chlorinated salts as lactate and diacetate (Devlieghere et al., 2009), taste boosters such as arginine, lysine, sodium inosinate, sodium guanylate, taurine, yeast extracts and monosodium glutamate

(Vidal, Paglarini, et al., 2020; Vidal, Santana, et al., 2020) among other approaches. To reduce salt in foods, de Oliveira Paula et al. (2019) suggested that technological interventions are needed. Other studies have, on the other hand, studied the functional problems linked with salt reduction in meat products, among is the replacement of NaCl on the sensory characteristics of sausages (Paulsen et al., 2014). Eight sodium-reduced sausages, prepared using four different levels of reduction; 0.7, 0.6, 0.5 and 0.2% with five different sodium substitutes KCl, milk minerals, combined sodium lactate and sodium diacetate, K-lactate and Na-Diacetate combined and potassium lactate were studied. Results from the study revealed that 0.6% of NaCl with 0.256% KCl had a significantly higher taste score compared to the control sample. This could mean that, when sodium content of sausages is reduced to the required levels, taste attributes will not be compromised, and might be preferred more than the regular products in the market. Partial replacement of NaCl by combinations of KCl and CaCl2 on the physicochemical, microbiological and physical characteristics of jerked beef were also assessed by Vidal and colleagues (Vidal & Biachi et al., 2019). From the study, treatment samples containing 50% NaCl with 50% KCl, 50% NaCl with 25% KCl and 25% CaCl2 reduced moisture content and exhibited the lowest lipids level. The outcome above illustrated once again that among salt replacers, KCl could be the only possible one which can be used alone to substitute salt without significantly affecting quality parameters of the sample. Meanwhile with the other salts, unless a combination of two or more of the chloride salts and/or addition of KCl could result in a quality product. The similar molecular function of KCl as NaCl (Barretto et al., 2020) might made the absorption of water to the internal protein structures of the meat more high compared to only sodium chloride. The reduced moisture in the meat samples help to avoid spoilage caused by hydrophilic microorganisms, thereby promoting a safe and healthy product for consumption. Cluff et al. (2017) also researched on sodium reduction strategies and its effect on the chemical, microbial, textural and sensory characteristics of bologna sausages. The total viable count (TVC) of the two-intermediate containing the least additional NaCl content of 1.33% and 1.84% were the most preferred than the control group which contains the highest NaCl level. However, the meat product was still favorable in terms of microbial load. So therefore, reducing the amount of NaCl in meat products should not be a problem. Furthermore, the TVC results across all treatments of which NaCl is not inclusive was well less than the national microbial expected limit of < 6 log cfu/g for processed meat products (SANS 885, 2011). This could mean that, reducing the amount of NaCl in meat and meat products to meet the WHO recommendation will not result in multiple microbial loads in the products. Additionally, Pietrasik and Gaudette (2015) also used the collective effect of partial salt substitution with improved potassium chloride and high pressure technology (600 MPa for 3 min at 8 °C) to enhance the quality and longevity of modernized cooked hams with reduced sodium that is naturally cured. Although some people seem to find it difficult to achieve salt reduction, others also find more sophisticated methods to ensure that salt is reduced in meat and meat products. Consistent with the NaCl reduction approach, it is possible to achieve a targeted reduced sodium levels without substantially compromising microbial stability in nitrite-free processed meat products, which is consistent with the findings from Cluff et al. (2017), where treatment groups with 46.8% and 26.4% of their NaCl content reduced, were compared similar to the control group with no substantial changes in TVC. Mora-Gallego et al. (2016) postulated a reduction of sodium chloride and fat contents in fermented sausages using potassium chloride and sunflower oil and evaluated the sensory and consumer acceptability. The effect of the concurrent decrease in the amount of fat (from 20% to 10% and 7%) and added salt (from 2.5% to 1.5%) and the conforming addition of 0.64% KCl and sunflower oil (1.5% and 3.0%) on the physicochemical, instrumental color and texture, sensory characteristics and consumer satisfaction of small caliber non-acid fermented sausages were carried out. Simultaneous reductions in salt and fat have contributed to a large rise in the acceptability of consumers. This finding however, differs from the result reached by Tobin et al. (2012), who mentioned that higher salt containing frankfurters were more desirable to consumers than the lower salt versions. Consumer acceptability can be influenced by several factors such as information about the reduced or increased content of salt before tasting. However, if a consumer should eat prior to the sensory, the actual taste perception in regards to saltiness would be different. Also, when panels are kept under same condition, there is a possibility that, communicating their taste perception within each other might give similar results. Sensory analysis for consumer acceptability of a product might not be enough to determine how safe or unsafe a product is. Hence salt reduction or replacement in meat and meat products would be proper to ensuring an acceptable product while maintaining health standards. Desmond (2006) revealed that, in an attempt by the Food Standard Authority (FSA), UK in setting a salt model aimed at a 50% decrease in bacon and ham, a drop of 40% in burgers or patties and a 43% decrease in sausages proved futile as these reductions have been seen by the industries as unattainable. Sparks et al. (2018), revealed that, global sodium intake is twice the World Health Organization guideline and processed meats contributes nearly 10% of the daily sodium intake in diets. Dos Santos et al. (2015) stated that, consumption of processed meat contributes about 80% of sodium taken by the people in developed countries. Laranjo et al. (2017) also reported that reducing salt consumption by 3 g per day could reflect a decline in the totality of annual deaths between 44,000 and 92,000 and a savings of approximately $10-24 billion per year in health care. Chen et al. (2019) found out that the risk of high sodium diets has been realized by most consumers, thus since the 1970s, many attempts have been made in developing countries. Several non-governmental organizations (NGOs) have thrived for commercial intervention to reduce food salt levels, but limited information outlines the efficacy of the help. However, reducing salt has recently been a target of efforts to improve the consistency of packaged food supplies, including meat products (Trevena et al., 2017). Reducing the level of added NaCl by either partial substitution or total substitution is the direct way in lowering sodium content and from (Campagnol et al., 2011; Dos Santos et al., 2015; Inguglia et al., 2017), replacement with other chloride salts such as potassium chloride (KCl), magnesium chloride ($MgCl_2$) & calcium chloride ($CaCl_2$), plant extracts and suitable materials are on the increase. More so, Zhang et al. (2020) also investigated the impact of NaCl substitution with (KCl and Ca-ascorbate) at a certain concentration (15%) on salted pork micro-structure in an attempt to minimize salt in meat. The study revealed that, the Ca factor significantly suppressed the increase in Na content compared to K, and the substitution of sodium salt with potassium and calcium salts greatly decreased the salted pork's sodium content. After salting with KCl, muscle bundles were comparatively uniform in size and distribution and the results showed that KCl had the greatest result on the micro-structure of salted pork samples. Hence this review is intended to compile a comprehensive supporting data on salt reduction in meat and meat products, by revealing the negative impacts on human health without compromising on whether it is attainable or not.

1.1. Sources of Dietary Salt

Consumption of salt-dense foods is increasing in humans and various food elements contribute to the consumption of dietary salt. Among them are meat and meat products, bread and baking products, soft drinks, cereal and grain products, confectionery products, convenience foods, dairy products, eggs, oils and oil emulsions, sauces, dressings, spreads and dips, fish and seafood products, sweets, carbohydrates, honey and related products, fruits, vegetables, nuts and legumes (Bhat et al., 2020; Ruusunen & Puolanne, 2005). Vidal, Bernardinelli, et al. (2019) stated that meat products were considered as the key origins of sodium in the diet, so their intake could be partial in the sense of a balanced diet. Bread was established by Menyanu et al. (2019) as the leading food source that provided the maximum amount of salt in populations' diets, followed by meat and meat products. However, as major contributors to non-discretionary salt consumption, meat and meat products, brackish meat and fish, sauces, spreads, condiments, pizza pie, snacks, seafood, and ground or river water were listed. Processed meat products contain high amount of salt likened to fresh pork of similar weight with bacon containing more than twenty times the amount of salt (Menyanu et al., 2019). According to Hasenegger et al. (2018), 16.1% of salt in the diet originates from meat and meat products and dairy products contributes 14.0%. Among these food groups, meat products and cheese have contributed as much as possible to the overall dietary salt intake. Seasonings, containing salt and seasonings used in meals that are ready-to-eat were also estimated to account for 1.3 % of the overall dietary salt intake. Single-handed use of optional salt (home-based cooking or at the banqueting table) added 22.4% to the overall dietary salt consumption. However, the bulk of the salt consumed comes from processed foods, including meat and processed meat products.

1.2. Meat and Meat Products

1.2.1. Meat

Meat is the flesh of a carcass that is consumable. According to Godfray et al. (2018), meat is a good source of energy and some essential nutrients as well as protein and micronutrients such as iron, zinc, and vitamin B12. There is red and white meat, processed and unprocessed meat. The following; beef, veal, pork, lamb, horse, goat and mutton meat according to (Domingo & Nadal, 2017) constitutes red meat, whereas processed meat is commonly made of red meat that is cured, salted or smoked (some examples are bacon and ham), which generally contains high amounts of crushed fatty tissue (sausages). Compared to plant-based products, meat and meat products are strong hubs of vitamins and ample proteins (Biesalski, 2005; Weiss et al., 2010). Naturally, red and processed meat consumption is classified as carcinogenic to human beings. Domingo and Nadal (2017) revealed that the intake of processed meat and red meat has been related to an increased risk of human colorectal cancer. Meanwhile, one of the approaches for healthy food is the Dietary Approaches to Stop Hypertension (DASH) type dietary pattern (Gil et al., 2015). The reduction of salt in meat and meat products is a great approach to attain healthier products to stop hypertension, which corroborates (Gil et al., 2015). Macdiarmid et al. (2016) mentioned that, the renounced health and environmental aspects of sustainable diets are linked to the neglect of the popular and artistic aspects of diets, especially meat eating. Consumption of animal products and meat diets is progressively seen as increasing the risk of chronic diseases. Hence, consumer demands for healthier meat and meat products with reduced NaCl and other compounds such as fat, cholesterol, nitrites and calories are increasing worldwide (Zhang et al., 2010). Sustainable healthy meats must be related to the formation of regulatory salt intake through socio-cultural and personal values around meat eating. Therefore, generating a healthy food supply as a preventive health care policy would be a successful solution to improving health care (Decker & Park, 2010).

1.2.2. Meat products

Meat products are finished end products from animals. Animal products are by nature complex as a result of the high protein, lipid and mineral content that can lead to several masses of physical interactions and chemical reactions, causing changes in aroma, taste and appearance, hence offering a possibility of decreasing consumer acceptability of functional meat products (Weiss et al., 2010). Examples of meat products include sausages, bacon, burgers, frankfurters, salami and hot dogs. The concept of manufacturing food with a higher effect on health is based on the enrichment of original products with ingredients that promote health. Meat and meat products appear to be a good intermediate for the introduction of new products. If the meat products manufacturers wish to inspire meat eating, there is the need to face challenges and offer healthier decisions. Because processed meat products are among the major sources of sodium in the form of salt (Desmond, 2006). Lilic et al. (2015) have shown that, sodium level in meat burgers can be decreased without adverse effects on the sensory acceptability of the products. Salted meat products and sausages contain salt/sodium levels higher than the proposed targets of the FSA while burgers and certain poultry products are comparatively similar to the targets suggested (Sparks et al., 2018). Desmond (2006), revealed that in March 2004, a retailer in Ireland had a salt strategy and recorded a salt reduction target for bacon and ham from 5% to 2% and sausages from 5% to 3% in 2007. Therefore, in order to be in line with the FSA proposals, meat processors would have to lower their salt levels and provide alternative products to their existing ranges.

1.2.3. Meat quality

Meat quality can be defined as the physical appearance, smell, firmness, mouth feel, and tenderness of the meat product (Berri et al., 2019; Gullett et al., 1984). Toldrá (2017), mentioned that, "the organoleptically desirable taste and odor of meat develops on cooking". The world's most frequently eaten meats are pork and poultry, in the form of a wide diversity of products, both fresh and processed (Berri et al., 2019). In the human diet, meat and meat products play a significant role by providing a great source of minerals such as iron and zinc, B vitamins and proteins containing all nine essential amino acids (Fellendorf et al., 2015). According to de Oliveira Paula et al. (2019), salt plays a major scientific role in product manufacturing especially in the meat processing industry. One of the most crucial food seasonings in meat and meat products is sodium chloride (NaCl). Not only does it sustain the protection of meat products by limiting pathogenic organisms' growth and life, but it also enhances texture, color and flavor. The texture and tenderness of meat are enhanced by gelatinization and the capacity to retain water is increased (Desmond, 2006). Since volatile compounds are released during cooking from the food matrix, salt enhances the fragrance of meat products (Zheng et al., 2019). However, other factors critical to meat production, can also have a negative impact on the quality of meat and meat product. For example, the use of meat, such as pale, soft and exudative meat, with insufficient sensory and technical features, offers a pale color, flaccid and highly exudative texture (Haddad et al., 2018). The amounts of salt and fat are crucial indicators that affect the quality of a meat product. For a meat product to be acceptable, the seasonings which include salt should not overshadow the natural meat taste. The product would thus have the most important determinants of the overall acceptability of the processed meat.

1.2.4. Roles of salt (NaCl) in meat and meat products

In comparison with other foods, the amount of sodium in processed meats is naturally high because of its significant role in the functionality, microbial stability and sensory properties of these products (Kameník et al., 2017; Zhang et al., 2020). Sodium chloride plays a substantial role in the characteristics of water and fat binding, which allows for the creation of stable gel structures within meat products. By reducing water activity and decreasing the potential for microbial growth, it acts as a preservative (Pietrasik & Gaudette, 2015). However, studies conducted by researchers revealed that one of the key functions of salt in processed meats is the color perception it offers. For instance in frankfurters, lower salt levels such as 1.5% and 1% have been shown to cause a darker/deeper color compared to higher salt treatments (Tobin et al., 2012). Similar observation was stated by Fellendorf et al. (2015) who noted that higher salt samples in white puddings caused lower yellowness and no redness pattern was found when the fat and salt levels differed. Salt levels in meat samples have been found to have a significant effect on thickness and hardness (Tobin et al., 2012). Nonetheless, research has shown that consumers have considered low salt (1% to 1.5%) containing samples to be harder compared to the higher salt containing samples of 2% to 3% salt. This may explain the interaction with chloride ions in the higher salt samples as they bind closely to proteins rather than sodium, thus increasing protein negative charges, which may induce repulsion between myofibrillary proteins thereby resulting in myofibrillary protein inflammation (Fellendorf et al., 2015). Similarly, Desmond (2006) reported that due to the addition of sodium chloride, an improvement in the water holding ability of myofibrillar proteins in processed meat induced a decrease in cooking loss, thus increasing the tenderness of the meat. de Oliveira Paula et al. (2019) also reported that salt helps in the removal and solubilization of myofibrillar proteins, hence improving water holding and fat emulsification, which affects the yield and texture of the final product. Additionally, salt causes weight loss of processed cooked hams as research by Lopez et al. (2012) revealed that broiler breast fillets made with normal NaCl content recorded a decreased cooking loss values.

1.3. Influence of dietary salt on health

Globally, extensive dietary salt (sodium) reduction is been recommended by a wide population of public health and scientific organizations based on systematic reviews showing adverse health effects associated with excess salt consumption, in particular increased blood pressure (Armenteros et al., 2009; Doyle & Glass, 2010; He & MacGregor, 2010; Zhou et al., 2013). According to Robinson et al. (2019), dietary salt contributes to vascular dysfunction and a variety of possible mechanisms by which this dysfunction will happen is illustrated in Table 1. It is difficult for consumers to minimize sodium intake because greater portions of the sodium ingested in a diet comes from processed food, accompanied by naturally occurring sodium, and ultimately what is added in the kitchen. Many studies have correlated high salt consumption with high blood pressure, which advances the risk of cardiovascular diseases. More so, the consumption of salt is related to an increased risk of stomach cancer, obesity, renal failure, osteoporosis and other illnesses (Robinson et al., 2019; Vega-Solano et al., 2019). Vidal, Biachi, et al. (2019) proposed that reducing salt is the best intervention for individuals with high salt sensitivity in a preventive way.

Table 1. NaCl intake and its corresponding effects on the various human body parts according to the requirements of WHO (2016).

Concentration of salt (NaCl)	Body accumulation	Effects
Normal < 2.0g/day	Respiratory system	Sodium helps control blood pressure
	Excretory system	*Regulates fluid levels in the body.*
	Skeletal system	Regulates the function of muscles and nerves
	Skin	Decreases skin cramps
	Brain	Decreases fatigue and restlessness
Moderate ≤ 2.0/day	Respiratory system	Reduction in blood pressure
	Excretory system	Easy passages of urine when levels are high
	Skeletal system	Healthy muscle and nerve activity
	Skin	Moderate aging
	Brain	Hallucinations, decreased consciousness and coma
High >2.0g/day	Respiratory system	Vascular dysfunction and pathological left hypertrophy
	Excretory system	Renal dysfunction and impaired Na^+ handling
	Skeletal system	Potential reduction in bone mineral density and content

	Skin	Skin sodium deposition, inflammation and immune cell activation
	Brain	Impaired cerebrovascular regulation and altered sympathetic outflow

At concentration of salt column, the less than sign (<) is an indication of normal salt intake, less or equal to (≤) indicates moderate intake of salt while greater than (>) shows salt intake above the recommended intake.

1.3.1. Effect of dietary salt on blood and its circulation in the human body

Excessive dietary salt sodium has been reported to be related to blood pressure elevations. Physiological characteristics leading to blood pressure (BP)-independent effects of salt and subsequent salt consumption on cardiovascular outcomes were analyzed by (Robinson et al., 2019). Research findings revealed that, high dietary salt has a negative impact on both large and small artery functions in humans. Following high-salt diets, both salt tolerant and salt-sensitive participants displayed impaired endothelial function. Demonstrated in the research was a higher arterial stiffness in stable middle-aged people and impaired endothelial function through reduced nitric oxide bioavailability due to high-salt diet. Additionally, dietary sodium restriction decreased sympathetic vascular transduction and revealed that sodium is a marker of aging due to the effects of dietary salt on the skin and inflammation. The findings on high Na^+ verification, suggested that it decreases expression of superoxide dismutase (SOD) and causes cerebral artery vascular dysfunction. More so, high salt consumption increases the excretion of urinary calcium, which can increase the risk of osteoporosis (Robinson et al., 2019). One key idea endorsed in the above study, however, was the findings of high dietary potassium (K^+) as a hallmark of healthy diets which aligns with Zhou et al. (2013), that potassium is one of the major chloride salts as a substitute of salt used in hypertensive patients to lower systolic blood pressure and to lower systolic and diastolic blood pressure in normotensive regulation. Making it an effective accessory treatment for patients with hypertension and the future effectiveness of normotensive individuals in avoiding hypertension. Several studies have mentioned that even though K^+ is one major replacement of Na^+ in diets, its bitter taste has placed a limitation to its use (Campagnol et al., 2011; Dos Santos et al., 2015; Wen et al., 2019; Zheng et al., 2019). Even though, the bitter taste of K^+ will be undesirable to consumers, replacing part of Na^+ with K^+ might be preferred as compared to high levels of Na^+ which poses health implications to humans (Chen et al., 2019; Wen et al., 2019).

1.4. Salt Reduction Strategies

1.4.1. NaCl replacement by other salts

Overconsumption of meat and animal products high in sodium has made many researchers to find alternatives to NaCl by replacing or adding other ingredients to limit its availability. One of the key approaches to overcoming the harmful causes of salt on humans is to completely or partly substitute NaCl with different chloride salts, such as potassium chloride (KCl), calcium chloride ($CaCl_2$) and magnesium chloride ($MgCl_2$) (Zheng et al., 2019). The widely used salt replacer in low-or decreased salt/sodium foods is potassium chloride (Desmond, 2006; Lilic et al., 2015; Zheng et al., 2019). According to Lilic et al. (2015), the lowest taste preference assessment was offered to burgers from a first control group that were produced in a small meat factory and retail outlet with 100% sodium chloride typically used during burger development. The second formulation of the control group containing 25% less NaCl than the products of the first control group, along with other tested percentage reductions were evaluated with the idea of partial substitution of NaCl with other substitutes. Treatments such as 50% less sodium chloride and substituted by the same quantity of potassium chloride as the first and second control groups were also produced. The highest assessment was given to burgers made with a 25% reduction in NaCl. It was observed that, despite 50% reduction in salt, these treatments recorded the highest taste acceptability scores while the first control group recorded the lowest taste acceptability scores. Although potassium chloride tastes bitter, with the right combination of raw materials, the sodium content of meat burgers can be lowered by using other chloride salts. However, with up to 27.18%, extra sodium reduction in sausages still has high flavor scores (Rodrigues et al., 2020). According to Vidal, Santana, et al. (2020), application of lysine and yeast extract has lessened the undesirable sensory effects of adding CaCl2 as a substitute salt without altering the physicochemical consistency parameters and the safety of salted meat treatments. Zheng et al. (2019), found that the carbonyl content of myofibrillary protein (MP) increased moderately as NaCl was partly replaced by KCl and CaCl2. That further indicated that mixtures of chloride salts containing NaCl, KCl, and CaCl2 could better promote protein oxidation at the same ionic strength compared to single NaCl. Mixtures containing NaCl, KCl and CaCl2 increased the carbonyl content of MP and facilitated the oxidation of sulfhydryl by denaturation or unfolding of MP, thereby increasing the availability of amino acids comprising hydrocarbon side chain groups in the hydrophobic inner core, particularly at a lower degree of substitution (25%). In addition, the presence of chloride salt mixtures significantly reduced the storage modulus (springiness), water holding ability (WHC) and gel capability of MP gels in pork meat, due to the more dissociated and aggregated structure of MP gels, especially at a higher level of substitution (50%) of NaCl (Zheng et al., 2019). The researchers concluded that partial replacement of NaCl salt with KCl and MgCl2 has a massive effect on the functional properties of MP gels in low-sodium products. Because of the significance of sodium chloride for the functional, microbial stability and sensory properties of these products, the production of high-quality processed meats containing decreased quantities of sodium chloride is a major challenge facing industries according to (Pietrasik & Gaudette, 2015). Lilic et al. (2015), however, suggested that the content of sodium chloride can be reduced by substituting it partly with other chloride salts without limiting its sensory properties and market acceptance.

1.4.2. Salt reduction as a way of improving population health at low cost

Several researches have revealed that using other chloride salts, especially KCl, is the most common and widely used method for reducing NaCl in processed meat and meat products. Also, Zhou et al. (2013) stated that blood pressure can be raised by sodium, while potassium can minimize blood pressure. A report on rural families in China with prevalence of hypertension received normal and salt substitute treatment (Zhou et al., 2013). As their salt intake, 100% sodium chloride was given to the usual salt group and the salt substitution consists of 65% sodium chloride, 25% potassium chloride and 10% magnesium sulfate. Findings revealed that participants who obtained salt replacement had lower systolic and diastolic blood pressure than participants with normal salt group. It was postulated that salt substitution may provide a valuable remedy for both hypertensive and prehypertensive individuals. Because the routine line for substitution of salt either by industries, households or the individual is simple, feasible and without complications. Fig. 1 depicted variation in blood pressure measurement, after follow-up periods from the participants. The effect of salt on human health is very detrimental, and it takes utmost efforts and discipline to stick to its reduction. Several countries including high and middle-income nations, are adopting policies to minimize salt consumption in diets, if not totally eradicate it. The Australian Division of World Action on Salt and Health (AWASH) launched a 'Lower the Salt' initiative in 2007, on the agenda of government (Webster et al., 2014). In doing so, the approach adopted helped to lift the salt outline on the government program. The research also suggests that, diverse government advocacy strategies will elevate the importance of setting rules and regulations on citizens. Moreover, building trust in the food industry and providing the opportunity for cooperative action to minimize the amount of salt in food would be a key success factor. Webster et al. (2014) stated that, in order to reduce premature deaths from CVD, an extremely cost-effective way is when the government of a particular nation leads the salt reduction programs. This could be that, the forces that will make the processing industries or individuals to strictly adhere to this effect must be high. Also, with government involvement, acceptance will be easy since the advocacy will be broad.

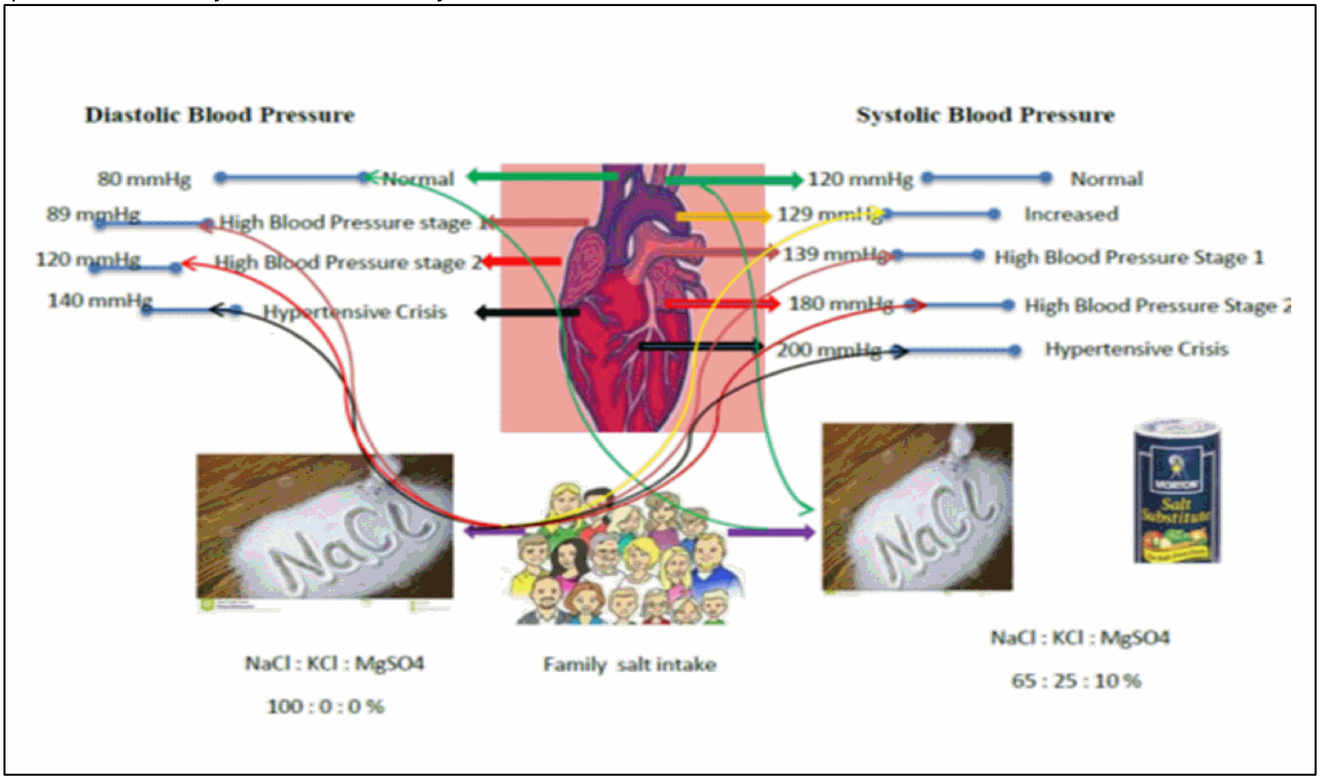

Figure 1. Measurement of blood pressure in families who consume normal salt (excess sodium) and salt replacement. For families with their salt levels partially replaced, substantial drops in blood pressure have been reported for both systolic and diastolic pressures.

1.5. Conclusion

Consumers' ultimate goal is to eat healthy diets. Although salt plays an outstanding role in meat and meat products for functionability, microbial protection and for sensory properties, as a result of the sodium present, decreasing its intake and/or replacing NaCl with other chloride salts is a remedy for chronic illnesses. From the findings in this review, the quantity of sodium consumed in meat and meat products exceeds the WHO-approved limit. This study showed, however, that it is possible to minimize and replace NaCl with other substances that have limited or no sodium content in meat and meat products without significant changes in the acceptability of the food products to consumers. Human health has become one big issue that cannot be underrated when it comes to consuming meat and meat products with sodium quantities exceeding the recommended intake. Since reduced sodium helps to lower the level of high blood pressure, lower the risk of cardiovascular and other severe diseases, which promotes a healthy lifestyle among families. Therefore, this study targeted and established several steps that can be put in place to limit salt consumption and also exposed the harmful impacts it has on human health. Knowledge about these implications can be a remedy in cutting down on salt addition by food processors, and consumption by consumers.

2.AUTHOR CONTRIBUTIONS

Theodora Ojangba and Zhuo Wang wrote, interpreted and drafted the research findings while
Li Zhang reviewed the manuscript.

3. CONFLICTS OF INTEREST

The authors declare no conflict of interest in relation to this article

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