

SODIUM REDUCTION IN PROCESSED FOODS, INCLUDING PROCESSED MEATS, IN AFRICA: A SYSTEMIC REVIEW

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ABSTRACT

The use of sodium in processed foods, including meats, has been in existent over centuries. Its use is mainly as a food and meat processing aid, and a preservative and flavourant. Even with modern methods of food processing, sodium is still essential in food and meat derivatives due to different dietary demands by consumers. Sodium chloride, sodium nitrate and nitrite are common in meat processing for various uses such as curing, smoking and brining. Due to the increasing global sodium intake, chronic adverse health effects, such as cardiovascular diseases, hypertension, stroke, cancers, among others, have also been on the rise, particularly in urban areas. African countries have a proportional increase of dietary sodium due to the adoption of western diets with high sodium and saturated fats. Subsequently, South Africa promulgated legislation that prescribed the first mandatory sodium limits in 2013. The purpose of this review is to determine, (1) the sodium reduction interventions agreed by African states in forums and meetings in the past five years (2017-2021) and, (2) sodium reduction strategies recommended through research by African scholars. This systemic review was conducted from English literature published between 2017 and 2021, using Science web, MEDLINE, CINAHL, PsycINFO, Science Direct, PubMed, Google Scholar, with a specific focus on African countries. From the findings of this systemic review, there were minimal sodium reduction interventions by African states, emanating from published forums and meetings, to establish collaborated sodium reduction strategies in processed foods. The studies conducted by African scholars in the past five years recommended sodium reduction interventions, such as legislative framework, product reformulation, monitoring models and consumer awareness, with most studies done in South Africa. It is evident that to have a meaningful impact on the control and reduction of dietary sodium, African countries require existing diplomacies to collaborate on sodium reduction efforts with public and private partnerships; this can be coordinated through inter-trade treaties among the African states. This requires an increase in research, commitment and the will to reduce dietary sodium in processed foods and meat by all member states.

Key words: sodium, reduction, processed, meat, processing, effects, hypertension, nitrate, nitrite



INTRODUCTION

Sodium is used in food processing and is physiologically required in the human body [1]. Sodium maintains the optimum functioning of the cell membranes, helps with nutrient absorption during digestion and regulates the volume of extracellular fluid [2]. Sodium compounds such as sodium chloride (NaCl), sodium nitrate (NaNO₃) and sodium nitrite (NaNO₂) are vastly used in meat products to improve taste and for preservation [3]. Table 1 provides a non-exhaustive summary of the types of sodium used in processed meat and their functions.

Consumption of sodium

Due to urbanisation, dietary habits of people worldwide have changed from traditional diets that was dominated by greens, fruits and dairy, to western diets that are dominated by energy dense processed fast foods [4]. This is due to the easy availability of energy-dense foods such as processed meats, refined grains, added sugar and saturated fatty foods [5]. Peters *et al.* [6] indicated that in United Kingdom (UK) and United States (US), processed meats contribute to more than 20% of total dietary sodium intake; in Africa, it is estimated to be higher, with the highest, 60 % in South Africa.

Adverse health effects of high dietary sodium consumption

An excess continuous consumption of high sodium in diets may have adverse health effects on certain human organs [7]. Figure 2 indicates vital human the organs that may be vulnerable to consistently high sodium intake.



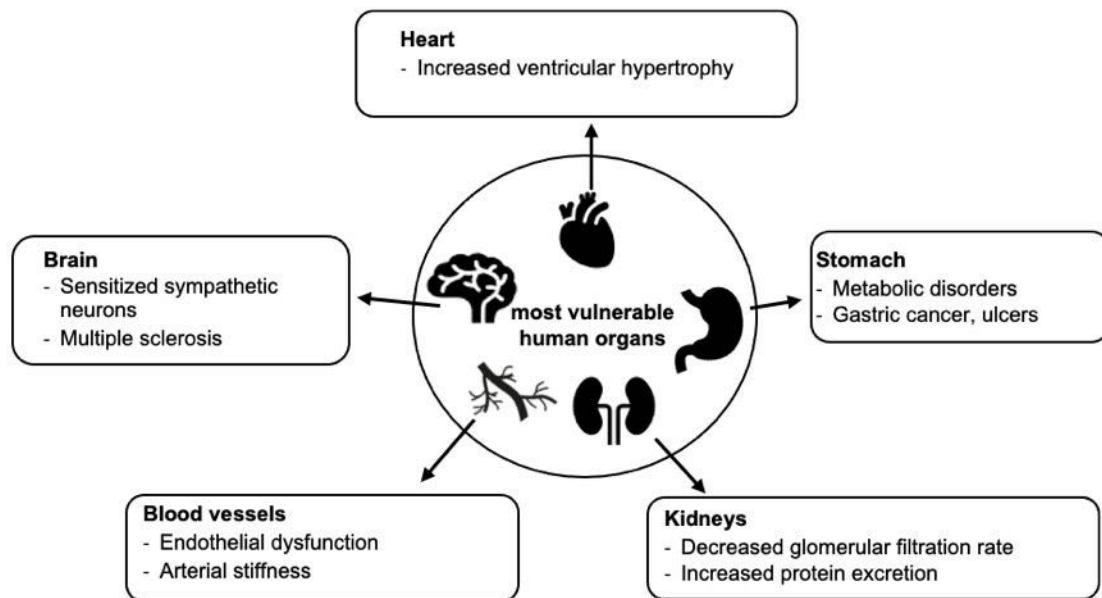


Figure 1: Illustration of the most vulnerable human organs due to high sodium dietary intake (Source: Authors own creation)

Even though hypertension relates to heredity and arterial complications, it is also a condition of concern associated with high sodium intake; it is the most important risk factor for cardiovascular disease (CVD) and the leading cause of death globally [8]. Consequently, in Africa, as a result of continuous high sodium consumption, sodium related diseases such as cardiovascular diseases, accounted for 16% of deaths in South Africa in 2013, of which 50% was as a result of stroke and 42% ischaemic heart disease [9].

Sodium reduction strategies in Africa

High sodium in processed foods has an impact on human health, and therefore strategies to reduce dietary sodium emerged globally in the past two decades [10]. It was for this reason that the World Health Organization (WHO) recommended a daily total sodium consumption of less than 5 g/day per person for member states in 2007 [11]. This recommendation was intended to reduce and manage sodium consumption to 2 g/day per person by 2020 [12]. This review was to determine the various sodium preventive, control and management measures suggested by collaborating forums and recommended by research scholars in relation to African countries. After the WHO recommendations on sodium reduction, South Africa became the first country in Africa to implement mandatory sodium reduction in processed foods including processed meats [13]. Trieu *et al.* [14] elaborated that, African states without mandatory sodium limits in processed foods, have shown no

significant will and urgency to that effect. Although there's commitment in sodium reduction, the challenge of food security in African countries might over shadow the urgency of compliance to sodium reduction [15]. Therefore, consumer awareness and education will play the biggest part of proactive sodium reduction strategy and to create sodium reduction intervention platforms to inform populations about the possible adverse health effects of continuous high sodium consumption [16]. Population monitoring on sodium consumption, acquiring current and reliable population consumption data is a more feasible approach [17]. Strict management of international traders (imports and franchisers) of suspected products that have been on the rise in Africa is essential, this was stated by Schönfeldt *et al.* [18] as a result of data indicating an influx of eateries with Western processed foods such as processed meats and ready to eat meals with high sodium and saturated fats loaded options. Africa must go beyond the control of sodium on the table, and adopt sodium reduction from the source, such as product reformulation, and legislation as supreme strategy in order to sanction transgressors [19].

MATERIALS AND METHODS

This review was derived from English literature published from 2017 up to 2021 and sourced from science web MEDLINE, CINAHL, PsycINFO, Science Direct, PubMed and Google Scholar focusing on African countries. The graphic software used were LP Rusinova, CoverageTool, GIS tools and 3D graphic software. The key words used for the literature search included sodium reduction, processed foods and East African countries OR Central African countries OR Northern African countries OR Southern African countries OR Western African countries OR Oceania African Island countries. Grey literature from the WHO's web page was included for recommendations of sodium levels in foods and the South African Centre for Disease Control and Prevention web page for sodium control strategies. Figure 2 shows the search methodology of the literature followed, as per PRISMA guideline [20].

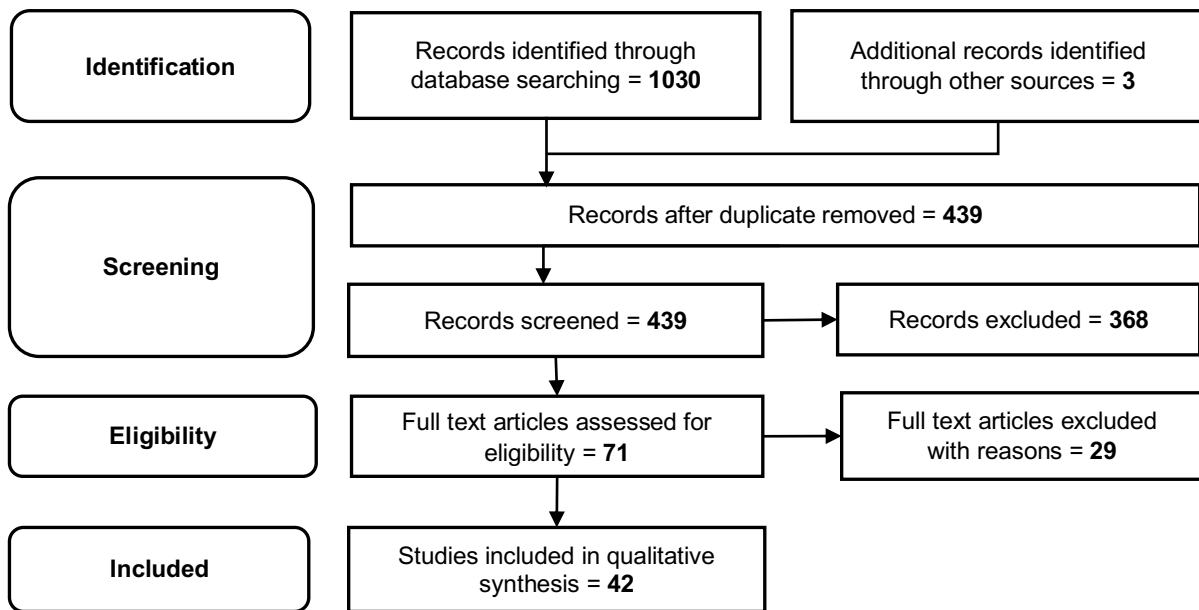


Figure 2: Review procedure followed for the literature review

Screening was done by excluding duplicate material, records with no specific reference to sodium reduction, African regions or country names, or research in languages other than English. To emphasise the health effects of high sodium intake, there were electronic art diagrams created using graphic software. In consideration of advances made in the sodium reduction strategies in African countries, there were tables created reflecting the aims and suggested control measures resulting from published forums and research.

RESULTS AND DISCUSSION

When the key words were used on “Any time” search in science webs, the results indicated that the foremost African recommendation on the community-based sodium reduction in processed meats, was as recent as 2007. Figure 3 shows the developments in sodium reduction interventions and sodium related research in African countries in the last five years (2017-2021). During this period, African studies with recommendations of sodium reduction in processed foods including processed meats took place in Benin, Egypt, Ghana, Kenya, Malawi, Morocco, Mozambique, South Africa, Rwanda, Sudan, Tunisia and Zambia.

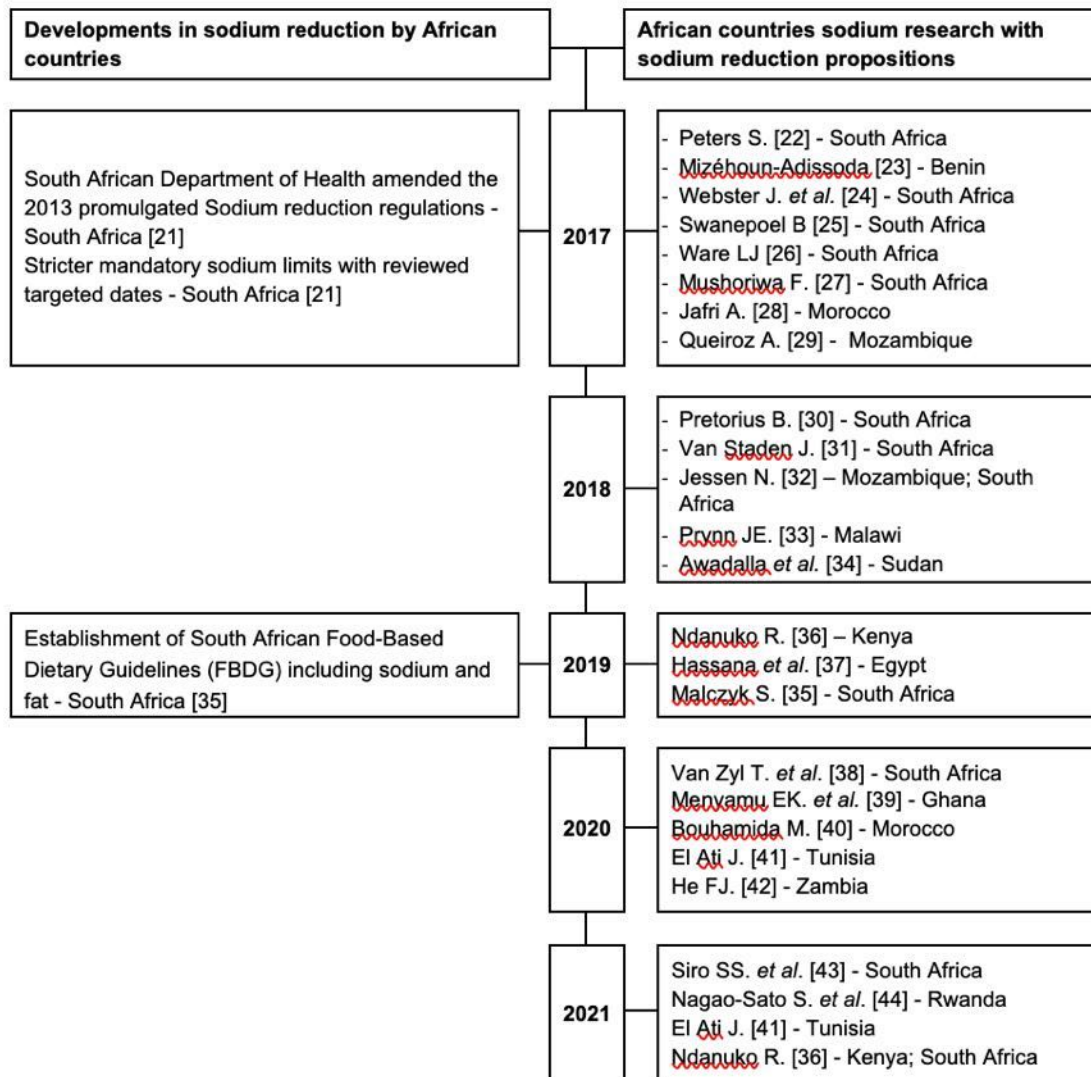


Figure 3: Developments and research in sodium reduction in Africa (2017-2021)

Developments in sodium reduction strategies and research in Africa

Table 2 provides a summary of the aims and outcomes of sodium reduction research conducted in African countries in the past five years (2017 - 2021). Figure 4 indicates the summary of integrated outcomes and recommendations regarding sodium reduction strategies and implementation.

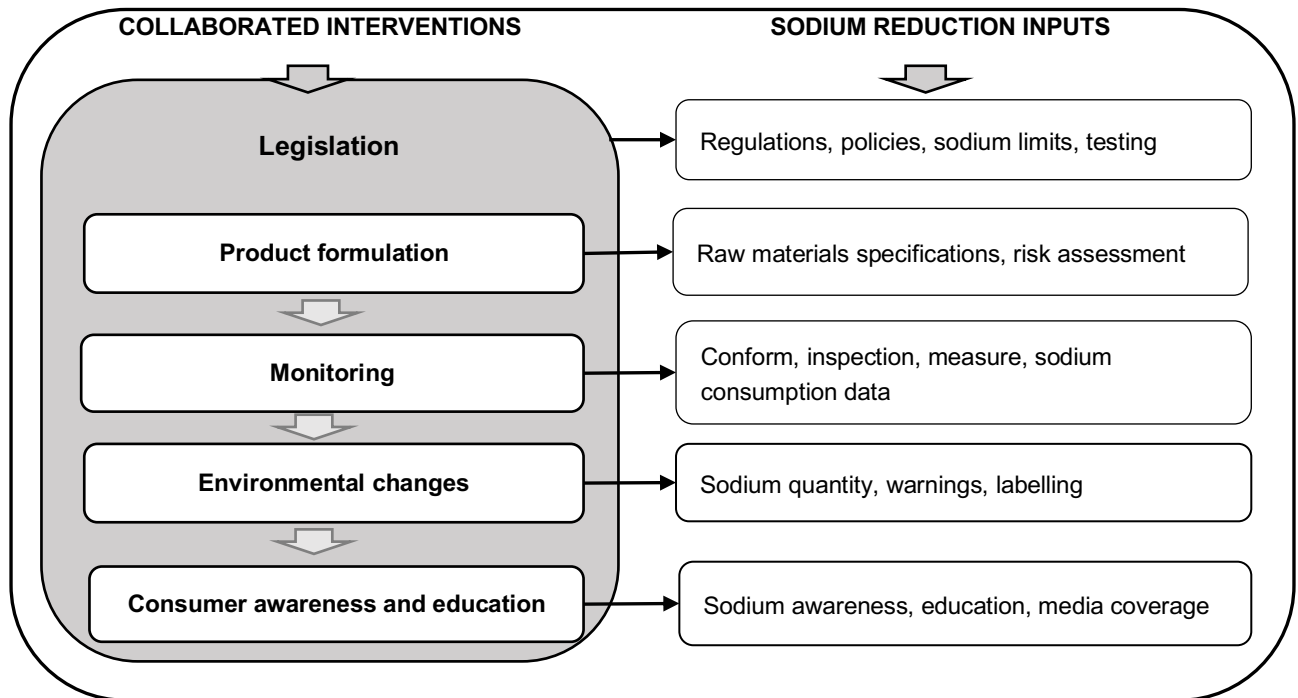


Figure 4: Summary of sodium reduction strategies recommended by African studies (Source: Authors own creation)

The recommendation of dietary sodium reduction by the WHO to member states resulted in the formation of technical groups by government agencies in Africa and around the world to advise member states on sodium reduction. It was due to this outcome that the South African government formed a working group that developed sodium reduction regulations that were subsequently promulgated in 2013 [22]. Other African states have since adopted the South African mandatory sodium limits as a guideline [32].

Legislative initiatives and sodium reduction programmes in Africa

Globally, there has been recognisable developments in the establishment of sodium reduction legislations. The first African country that legislated mandatory sodium measures was South Africa [24], with the promulgation of the “Regulations relating to the reduction of sodium in certain foodstuffs and related matters” in 2013 (as amended in 2017 and 2019) [21]. Annexure 1 of the regulation provides for the categorisation and classification of processed foods applicable to the regulation and specifies limits for each of the categories. For example, Category 7 (Processed meat) provides for Total Sodium Limits for Class 1 products (Comminuted, cured, heat treated as 1300 mg/100 gm) and Class 4 products (Reformed, cured, heat treated as 1150 mg/100), targeted for achievement by April 2020 [25]. There are, however, no other African countries that have set their

regulations or standards since [45]. For lack of or no legislation by other African countries, it would have been ideal to adopt the South Africa legislation in the interest of sodium reduction and public health. Legislators should explore voluntary measures against mandatory measures as a start. For example, establishing of a mutually agreed national policy between legislators and processed food industries that combines voluntary compliance to standards, monitoring interventions and education of communities can serve as initial strategy to reduce sodium in processed foods.

Recommended products for reformulation

Sodium replacement during food product reformulation can also be explored during manufacturing. Pateiro *et al.* [46] recommended that a sodium reduction strategy should include sodium substitution during product formulation and processing. The South African legislation prescribed mandatory sodium limits without prescribing alternative sodium control measures, such as food processing substitution and raw material replacement with compounds with lesser effects than sodium, such as Potassium, salt free seasoning blends and coconut aminos introduced over time [10]. It is seen that these requirements require concerted partnerships, monitoring, commitment, and resource allocation be considered to be able achieve the 25% reduction by April 2020 [24].

Environmental changes

Environmental changes refer to setting of targets, standards for food manufacturers and providers (including labelling), aligning sodium reduction programmes through stakeholder partnerships to develop policy and promote research, monitoring and communication at national and international levels. The use of simple traffic light colour coding (red, yellow and red) to indicate the level of sodium content among other ingredients in the product can be promoted, as it will be easily understood by consumers [47].

Monitoring of sodium reduction strategies

Monitoring sodium reduction initiatives remain critical in assessing and evaluating the progress as well as shortcomings. Government and health agencies require renewed efforts of compliance monitoring and surveillance because there is no reliable and current population database for sodium consumption maintained in many or most of the African countries. The success of the implementation of the sodium reduction strategy is reliant on strong leadership, scientific research and willingness of leadership in governmental institutions and the food industry to reduce sodium intake, in the public interest.



Consumer awareness and education

Meaningful sodium reduction initiatives in African countries should include consumer awareness on the adverse health effects of excessive sodium consumption. Consumer education should extend to interventions in public schools, hospitals and places of work. In Africa, there has been a hand full of inter-state sodium reduction forums and meetings held as part of consumer education and information gatherings; however, there is no reporting of the successes and failures of these interventions.

CONCLUSION

Global sodium intake, due to processed foods, is higher than the WHO's daily consumption recommendations. Similar to global trends, this review indicated that the African population's sodium intake is also high, and without collaborative efforts, there will be little or no progress in dietary sodium reduction. The major contributing foods in population sodium intake are processed foods, of which processed meat accounts for the highest contribution. The health impacts of high sodium intake relate to cardiovascular diseases, cancers, kidney deficiencies and other chronic diseases.

Sodium reduction strategies are necessary to significantly curb and intercept the high sodium concentration in foods. Strategies recommended include the establishment of legislative and policy interventions by government agencies, feasible product reformulation guidelines, environmental changes of processed foods (including food labelling), and monitoring programmes to determine compliance by food industries, population sodium intake database, the level of consumer awareness, attitude and practices regarding sodium reduction and the effectiveness of the strategies in combination. These strategies need customising for Africa, and they require a comprehensive and collaborative effort between government agencies and policymakers on national and international levels, including import and export treaties.

Ethics Statement

Ethics approval for the study was obtained from The Tshwane University of Technology, Faculty of Science Committee for Research Ethics, granted ethical approval: (code FCRE2016/07/005(2)(SCI)).

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Author Contributions

EJM was responsible for the study preparation, design, coordinating, information collection and drafting the manuscript for his Master's degree. JLB and NSM were responsible for supervision, technical advice, guidance and editing of manuscript. All authors have read and approved the manuscript.

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Conflict of Interest

The authors declare they have no competing interests.



Table 1: A summary of the types of sodium used in processed meats and its function

Name of sodium types	Characteristics and functions as a food processing aid	Reference
Sodium	<ul style="list-style-type: none"> Reduces microbial growth by breaking down the meat muscle tissue for the fermentation process to produce lactic acid The lactic acid not only preserves the meat, but lowers the pH on the meat and destroys the harmful microorganisms 	Engevik [48]
Sodium chloride (NaCl)	<ul style="list-style-type: none"> Bind water causing a reduction of the water activity (aw). Prevent spoilage and increase product shelf life Acts as a flavouring agent 	Haddad [49]
Sodium nitrite (NaNO ₂)	<ul style="list-style-type: none"> React with red meat pigment to enhance the heat stable red curing colour ("pickling red") Has a pH effect in meat with the ability to inhibit or kill bacteria Delays growth of microorganisms such as <i>Clostridium botulinum</i> of botulinum toxin formation Delays rancidity of meat during storage 	
Sodium nitrate (NaNO ₃)	<ul style="list-style-type: none"> An alternative curing substance to NaNO₂ 	Yim [50]
Sodium ascorbate (C ₆ H ₇ NaO ₆)	<ul style="list-style-type: none"> Used with NaNO₂ to accelerate the reaction of nitrite resulting in the red curing colour Curing reaction is more complete with less residual nitrite in the product 	
Sodium erythorbate (C ₆ H ₇ NaO ₆)	<ul style="list-style-type: none"> Red colouration of cured products Accelerate the reaction of nitrite 	Sallan [51]
Sodium tripoly-phosphate (STPP) (Na ₅ P ₃ O ₁₀) (pH 9.8)	<ul style="list-style-type: none"> Improve binding by increasing water-holding capacity Stabilise texture by increasing protein solubility in connection with sodium and reduce lipid oxidation/rancidity Has the ability to reduce microbial growth 	
Sodium di-phosphate SDP (pH 7.3)	<ul style="list-style-type: none"> Used as emulsifier in food processing Used as a binding agent Increases the viscosity of foodstuffs 	Zeeb [52]
Monosodium glutamate (MSG)	<ul style="list-style-type: none"> Enhances flavour in foods. Provides a distinctive aroma and savoury taste in processed foods 	Engevik [48]

Table 2: Summary of African countries' sodium reduction recommendations derived from research

Author(s)	Country	Objective of the research	Sodium reduction strategies and implementation recommended by the studies
Webster <i>et al.</i> [24]	- South Africa	- To assess the state of implementation of mandatory sodium reduction	<ul style="list-style-type: none"> - Population awareness and change consumer behaviour - Promotion of sodium reduction through media campaign - Support industry compliance - Legislative framework - Implement the next stage of SALT WATCH campaign
Hassana N. <i>et al.</i> [37]	- Egypt	- To determine the health effects and relationship between sodium, fat and calcium	<ul style="list-style-type: none"> - Change in eating habits and lifestyle
Swanepoel B. [25]	- South Africa	- The comparison of the development of sodium reduction strategies between UK and South Africa	<ul style="list-style-type: none"> - Determine if mandatory programmes will be more effective than voluntary approach
Menyanu E. [53]	- South Africa and Ghana	- To analyse sodium related knowledge, attitude and behaviours (KAB) amongst adults in Ghana and South Africa	<ul style="list-style-type: none"> - Improved health awareness campaigns that will have an impact on behaviour related to the use of sodium
Mizéhoun-Adissoda C. [23]	- Benin	- To determine the dietary sodium and potassium intake concentration in urine	<ul style="list-style-type: none"> - Promotion of high potassium foods with the intention to reduce sodium consumption
Azuma SL. [54]	- Ghana	- To determine the level of sodium benzoate in soft drinks and the health risks consumers are exposed to	<ul style="list-style-type: none"> - Regulated thresholds - Intensive monitoring of products
Ware LJ. [26]	- South Africa	- To discover the connection between sodium, blood pressure and the influence of age	<ul style="list-style-type: none"> - Substitution of sodium with potassium - Sodium dense diet leads to high probability of hypertension
Van Staden J. [31]	- Benin, Guinea, Kenya, South Africa, Mozambique and Seychelles	- To define and compare the knowledge, attitudes, and practices (KAP) of five countries adults toward sodium reduction in foods	<ul style="list-style-type: none"> - Consumer awareness by means of educational drive and campaigns - Food labelling with indications of sodium content in foods
Queiroz A. <i>et al.</i> [29]	- Mozambique	- To evaluate sources of dietary sodium in staple foods	<ul style="list-style-type: none"> - Modify communal eating habits



Author(s)	Country	Objective of the research	Sodium reduction strategies and implementation recommended by the studies
Awadalla H. <i>et al.</i> [34]	- Sudan	- To evaluate the occurrence of hypertension as a result of sugar and sodium intake	- Legislation enforcement - Health authority to advocate for the decrease of sodium in foods
Jessen N. <i>et al.</i> [32]	- Mozambique, South Africa	- To determine the pattern of sodium in bread	- Establish mandatory sodium limits for target processed foods - Gradual sodium reduction during formulation processes - Consumer awareness and education in collaboration with government and civil societies
Ndanuko R. <i>et al.</i> [36]	- Kenya, South Africa	- To estimate compliance of sodium labelling in packaged foods - Evaluate the level of sodium in pre-packaged foods	- Innovate and enforcement of labelling requirements related to sodium content of processed foods - Introduce product reformulation specifications as policies
Jafri A. <i>et al.</i> [28]	- Morocco	- To determine the level of sodium levels in commercial white bread	- Establish a collaborative model with food industry - Reform product formulation processes from manufacturing phases
Noubiap J.J. [55]	- Morocco	- A call to rapidly implement sodium reduction interventions in African countries	- Develop usable legislative reforms with clear sodium limits - Promote population awareness through instances such as media - Monitoring population sodium consumption



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