International Journal of Engineering Science Invention (IJESI)
ISSN (Online): 2319-6734, ISSN (Print): 2319-6726
www.ijesi.org ||Volume 9 Issue 2 Series. I || Feb.2020 || PP 51-55

Quantification Of Chloride And Sodium In Cured Meat Products

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ABSTRACT: *Meat products represent a source of animal proteins in the human diet, many of which are present daily in diet of most people. One of dangers associated with excessive consumption of this product is excess of sodium chloride which can lead to hypertension, kidney stones, fluid retention among other problems. Aim of this work was to quantify content of chlorides and sodium in cured meat products. Chloride content was quantified using official methodology of Adolf Lutz Institute where samples are weighed, incinerated to obtain light ash, titrated with 0.1M silver nitrate solution until appearance of a brick-red color. Sodium content was obtained indirectly following correlations of Pan American Health Organization which recommends that 1 gram of salt contains 400 mg of sodium. Chloride content in mineral residue ranged from 2.45 to 31.01%, that of sodium ranged from 176 to 12404 mg Na 100 g^{-1}. This means that consumption of some of analyzed products exceeds values recommended by World Health Organization, leaving consumer liable to develop several diseases.*

KEYWORDS*: Cured meat products, sodium, ashes, sodium chloride, legislation, hypertension.*

Date of Submission: 04-02-2020 Date of Acceptance: 20-02-2020

I. Introduction

Salt (sodium chloride) is oldest method of preserving food, addition to enhancing natural flavor of food, being widely used industrialized foods in general, mainly cured meat derivatives associated with curing salts: nitrite and nitrate, sodium. Cured meat products such sausages, hams, bologna, hams, sausages, sausages are widely consumed due to their nutritional value (proteins, lipids), due to affordable price (Borges et al., 2019; Borges et al., 2020).

Main source of sodium diet is common salt (40% sodium), which is routinely added in kitchen, food processing. Sodium plays important role human body absorption of nutrients small intestine, maintains potential of cell membranes, and regulates extracellular liquid volume, also influencing blood volume and blood pressure, responsible for acid-base balance, water balance body, and neural functions. Its absence can lead to muscle cramps, mental apathy, reduced appetite. Approximately 90% of sodium body comes from edible salt human diet (Kloss et al., 2015; Kameník et al., 2017; Ludwig & Guimarães, 2017).

Deficiency sodium consumption can cause several damages, however excessive intake results health problems, such increased arterial hypertension (Capuano et al., 2013), cancer stomach, especially carriers of bacterium *H. pylori* (INCA, 2019). Arterial hypertension is associated with high rates of morbidity and mortality, constituting one of major public health problems world. It is one of biggest causes of strokes, cardiovascular diseases, kidney failure and premature death worldwide (Costa & Machado, 2010). According to PAHO/ WHO, (2019), high salt consumption, even during childhood, has effect on blood pressure, can predispose children to diseases such as hypertension, osteoporosis, asthma, other respiratory diseases, obesity, cancer of stomach. Adults who consume more than 2000 milligrams of sodium daily (equivalent to 5 grams of salt per day) are at higher risk of developing high blood pressure, main risk factor for cardiovascular disease, well as kidney failure. Due to various health problems associated with excessive salt consumption, there has been demand from health agencies for food industries to gradually reduce salt content processed foods, some researchers are looking for ways to partially replace sodium chloride products meat, without changing sensory characteristics. Aim of this work was to quantify chloride and sodium content cured meat products.

II. Materials And Methods

II.1 Study location and sample preparation

Samples of meat derivatives were purchased cities of Petrolina-PE and Juazeiro-BA. Petrolina is municipality state of Pernambuco, located in San Francisco Valley region, neighboring municipalities of Juazeiro and Sobradinho. Located at 380 meters of altitude, latitude 9° 23' 39" South, longitude 40° 30' 35 " West. Juazeiro is city state of Bahia. Neighboring municipalities of Petrolina and Sobradinho, Juazeiro is located 5 km south-east of Petrolina. Located at 369 meters of altitude, latitude: 9° 26' 18" South, longitude: 40° 30' 19" West. 38 types of cured meat products (seven sausages, two paios, three Italian salami, four hamburgers, eight bologna, seven hams, three lower hams, and four hot dog sausages) from different commercial brands were analyzed. Samples were kept refrigerated environment, at temperature of 4 °C. Samples were ground individually meat grinder at time of analysis.

II.2 Sodium chloride content in cured products

Quantification of chlorides samples was done two stages: obtaining and quantifying ash (minerals), chloride analysis. Mineral residue was determined by gravimetric method with sample incineration (5 g) muffle heated to 450 ºC until light ash was obtained. Ashes were added 2 drops of nitric acid solution (1 + 9) to facilitate dissolution, 10 mL of heated distilled water. Samples were homogenized, filtered in 250 mL erlemeyer. The pH of solution was adjusted to 5.5 using calcium carbonate directly in beaker. 1 mL of 5% potassium chromate solution was used as indicator; samples were titrated with 0.1 M silver nitrate solution until appearance of brick red color (IAL, 2008). All tests were performed triplicate. Chloride concentration fresh sample was calculated using equation 1:

$\%\ Nacl = V \times N \times f \times 0{,}0585 \times 100/P_1$ (eq. 1)

Concentration of chlorides in mineral residue was calculated using equation 2:

$\%\ Nacl = V \times N \times f \times 0{,}0585 \times 100/P_2$ (eq. 2)

Where: V = volume of 0.1 N silver nitrate solution, spent on titration, in mL; N = normality of 0.1N silver nitrate solution; f = correction factor of 0.1 N silver nitrate solution; P1 = mass of sample, in grams; P1 = mass of mineral residue; 0.0584 = milliequivalent gram of sodium chloride.

Sodium content in mineral residue was calculated indirectly by multiplying chlorides mineral residue by 400 mg. According to Pan American Health Organization, 1 gram of salt contains 400 mg of sodium (PAHO / WHO, 2019).

III. Statistical Analysis

Statistical analysis was performed by One-way ANOVA, using STATISTICA® 7.0 program, values considered significant with $p > 0.05$. All determinations were performed triplicate (N = 3), data were expressed as average ± standard deviation. Results were compared using the Tukey test to identify existence of significant differences between test results, with significance level of 95% for each evaluated parameter.

IV. Results And Discussion

Table 1 show results obtained chloride and sodium quantification tests on cured meat derivatives. It can be noted that chloride content fresh product varied from 0.77 to 2.83%. Most samples showed significant difference when compared by Tukey test.

According to Brazilian Normative Instruction N°. 17, of May 29, 2018, salt content, plus condiments, must represent at least 1% (one percent) of product formulation. Based on this law, only four samples analyzed showed levels acceptable under Brazilian law, eight samples showed to have twice what is allowed by law. Normative Instruction N°. 22, July 31, 2000 of Ministry of Agriculture, Livestock and Supply (MAPA) which approves Technical Regulation on Identity, Quality of Meat Derivatives (Jerked Beef Cup, Parma Ham, Raw Ham, Salami, Salami), Colonial sausage and pepperoni) establishes that percentage of mineral matter in these products is maximum of 18.3%. Ash consists mainly of K, Na, Ca and Mg. Higher content of mineral residue sample, greater possibility of having high content of chlorides.

Chloride content in mineral residue ranged from 2.45 to 31.01%, that of sodium ranged from 176.00 to 12404 mg Na 100 g^{-1}. These data are worrying since sausage products, such as sausages and bologna, are very popular, being consumed both at home, fast food market, representing important segment of industrialized meats (Paes et al., 2011; Ludwig & Guimarães, 2017). Aaslyng et al. (2014) when analyzing Danish crushed meat products such as sausage, cooked hams found average salt content of 2.19% and 2.28%, respectively. Capuano et al. (2013) detected between 759 mg 100 g^{-1} in Frankfurter sausage, 1050 mg 100 g^{-1} ham that corresponded to average salt ratio of 1.93 to 2.66%. Kameník et al. (2017) analyzed 133 samples of 5 meat products, found sodium levels ranging from 558.00 to 1308.00 mg Na 100 g^{-1}, with total of 75 of 79 meat product samples

having higher salt content based on sodium content. Frankfurter sausages had salt content ranging from 1.93% and 1.71% of salt content.

Table 1. Chloride and sodium content in cured meat products.

Samples	Chlorides in fresh sample (%)	Chlorides in mineral residue (%)	Sodium in mineral residue (mg)
Leg sausage A	1.40^{s} ± 0.01	5.30^{k} ± 0.01	2120.00^{k} ± 0.00
Chicken sausage B	1.41^{s} ± 0.01	2.47$^{\varpi}$ ± 0.01	988.00$^{\varpi}$ ± 0.00
Smoked Pepperoni Sausage C	1.63^{p} ± 0.02	6.33^{x} ± 0.02	2532.00^{x} ± 0.00
Tuscan sausage D	1.56^{q} ± 0.02	4.51$^{\&1}$ ± 0.01	1804.00$^{\&1}$ ± 0.00
Sausage Calabrese Gold E	1.74^{n} ± 0.01	2.51$^{\Omega}$ ± 0.00	1004.00$^{\Omega}$ ± 0.00
Sausage Calabrese F	1.74^{n} ± 0.00	2.47$^{\varpi}$ ± 0.00	988.00$^{\varpi}$ ± 0.00
Chicken sausage G	1.33^{u} ± 0.03	2.45$^{\varpi}$ ± 0.00	176.00$^{\varpi}$ ± 0.00
Paio A	1.80^{m} ± 0.01	7.30^{s} ± 0.02	2920.00^{s} ± 0.00
Smoked Paio B	1.82^{m} ± 0.01	6.51^{v} ± 0.01	2604.00^{v} ± 0.00
Italian salami A	1.71^{0} ± 0.01	5.51^{z} ± 0.01	2204.00^{z} ± 0.00
Italian salami B	1.85^{lm} ± 0.02	7.20^{t} ± 0.01	2880.00^{t} ± 0.00
Italian salami C	1.83^{m} ± 0.01	8.90^{p} ± 0.01	3560.00^{p} ± 0.00
Hamburger A	1.39^{s} ± 0.01	4.43$^{\beta}$ ± 0.01	1772.00$^{\beta}$ ± 0.00
Hamburger B	1.36^{t} ± 0.00	4.64$^{\&}$ ± 0.01	1856.00$^{\&}$ ± 0.00
Hamburger C	1.38^{s} ± 0.02	4.43$^{\beta}$ ± 0.01	1772.00$^{\beta}$ ± 0.00
Hamburger D	1.56^{q} ± 0.01	3.41$^{\epsilon}$ ± 0.01	1364.00$^{\epsilon}$ ± 0.00
Mortadella A	1.50^{r} ± 0.00	3.93$^{\mu}$ ± 0.01	1572.00$^{\mu}$ ± 0.00
Mortadella B	1.71^{o} ± 0.00	11.50^{m} ± 0.01	4600.00^{m} ± 0.00
Mortadella C	1.71^{o} ± 0.01	6.85^{u} ± 0.00	2740.00^{u} ± 0.00
Mortadella D	2.44^{f} ± 0.00	10.40^{n} ± 0.01	4160.00^{n} ± 0.00
Mortadella E	1.93^{j} ± 0.01	7.78^{q} ± 0.01	3112.00^{q} ± 0.00
Mortadella F	2.23^{h} ± 0.00	20.31^{f} ± 0.01	8124.00^{f} ± 0.00
Mortadella G	2.57^{c} ± 0.02	23.37^{e} ± 0.00	9348.00^{e} ± 0.00
Mortadella H	2.54^{d} ± 0.00	31.01^{a} ± 0.01	12404.00^{a} ± 0.00
Turkey Ham A	2.17^{i} ± 0.00	10.47^{m} ± 0.00	4188.00^{m} ± 0.00
Ham B	1.87^{l} ± 0,02	16.75^{h} ± 0.01	6700.00^{h} ± 0.00
Ham C	2.83^{a} ± 0.00	12.37^{j} ± 0.01	4948.00^{j} ± 0.00
Ham D	0.79^{w} ± 0.00	9.59^{o} ± 0.00	3836.00^{o} ± 0.00
Ham E	0.77^{wy} ± 0.00	5.23^{w} ± 0.00	2092.00^{w} ± 0.00
Ham F	0.78^{w} ± 0.00	7.25^{r} ± 0.00	2900.00^{r} ± 0.00
Ham G	0.78^{w} ± 0.00	11.85^{l} ± 0.00	4740.00^{l} ± 0.00
Lower Ham A	2.67^{b} ± 0.00	23.72^{d} ± 0.00	9488.00^{d} ± 0.00
Lower Ham B	2.49^{e} ± 0.00	29.78^{b} ± 0.00	11912.00^{b} ± 0.00
Lower Ham C	2.31^{g} ± 0.00	24.13^{c} ± 0.00	9652.00^{c} ± 0.00
Hot dog sausage A	1.29^{v} ± 0.01	16.31^{i} ± 0.00	6524.00^{i} ± 0.00
Hot dog sausage B	1.23^{z} ± 0.01	19.89^{g} ± 0.00	7956.00^{g} ± 0.00
Hot dog sausage C	1.22^{z} ± 0.00	3.27$^{\alpha}$ ± 0.00	1308.00$^{\alpha}$ ± 0.00
Hot dog sausage D	1.25^{xz} ± 0.02	6.31^{x} ± 0.00	2524.00^{x} ± 0.00

*Values expressed as average ± standard deviation followed by equal lowercase letters in same columns do not differ statistically at 5% level (Tukey test).

Research by Ludwig & Guimarães. (2017) with total of 113 adolescents aged 15 to 17 years state school city of São Paulo, it was observed that young people consume high percentage of sausages: mortadella (85.8%), hot dog sausage (82.3%), ham (80.5%) and sausage (79.6%) because they are already part of school lunch, because they are easily available school cafeterias or sales points near school. Meat products are important source of sodium human diet, representing 20% (w / w) to 30% (w / w) of daily intake (Inguglia, Zhang, Tiwari & Kerry, 2017). Many people American countries, such as Brazil, suffer from hypertension, mainly due to excessive consumption of salt and sodium present processed foods, and / or ready for consumption (Taylor et al., 2018).

Sodium chloride is important ingredient meat processing, it has several technological properties, including: improved taste and texture, increased water retention capacity, gel formation, emulsion (by extracting myofibrillar proteins), can inhibit microbial growth. Therefore, refined salt (sodium chloride) cannot be completely eliminated from meat (Seganfredo et al., 2016) but can, should be partially reduced order to improve health and prevent diseases.

World Health Organization (WHO) recommends that adult should consume maximum of five grams (5 g) of salt or 2000 mg of sodium, at least 3510 mg of potassium per day. Considering that about two grams (2 g) are naturally present food, it is recommended that only three grams (3 g), equivalent to two shallow teaspoons, be added when preparing meals in day. One should pay attention to consumption of ultra-processed and processed foods rich in salt (INCA, 2019). This means that by consuming most of analyzed products daily,

people have already exceeded maximum recommended amount for consumption, are exposed to danger of developing various diseases.

World Health Organization (WHO), European Union (EU) has developed strategies to reduce sodium chloride (NaCl) consumption population (WHO, 2006; Council of European Union, 2010; Steffensen et al., 2018). In 2012, WHO strongly recommended reduction sodium intake to less than 2 grams per day or less for adults order to lower blood pressure, therefore risk of pressure-related disorders adults and children (WHO, 2016). Scientific studies have shown that reducing sodium consumption by decreasing consumption of processed foods leads to reduction in blood pressure (Aburto et al., 2013). These data led some authors to research alternatives for reducing sodium various foods. Raybaudi-Massilia et al. (2019) their research to quantify and partially replace NaCl with microspheres of Soda-Lo® salt (25% (w / w), 30% (w / w) W), 50% (W / W)) products based on meat, such cooked ham, turkey breast, sausage type Deli obtained positive sensory and microbiological effects this process, showing to be efficient, viable alternative. Other authors suggest replacing sodium chloride with other salts, usually containing potassium, magnesium or calcium (Dos Santos et al., 2015; Horita et al., 2014; Lorenzo et al., 2015; Paulsen et al., 2014).

V. Conclusion

Cured meat products are affordable alternative to consuming animal protein for majority of population. However, these products have great potential for health risk due to use of healing salts, excess of sodium chloride and consequently sodium. Only five of analyzed products had chlorine content below 3 g, majority of products had value that exceeded 5 g proposed by Ministry of Health. These data serve warning for population that wishes to consume these products, to do so controlled manner, avoiding daily consumption that could contribute to development of various diseases.

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Josileide Gonçalves Borges"Quantification Of Chloride And Sodium In Cured Meat Products." International Journal of Engineering Science Invention (IJESI), Vol. 09(02), 2020, PP0 51-55.