Consumer exposure to warmed-over flavour and their attitudes towards the use of natural antioxidants as preservatives in meat and meat products

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Abstract

Purpose – The objective of the study was to assess consumer exposure to warmed-over flavour, their eating habits with respect to pre-cooked stored meats, awareness of antioxidants and attitudes towards the use of natural antioxidants as preservatives in meat and meat products.

Design/methodology/approach – A total of 238 Check-All-That-Apply (CATA) design questionnaires were used to gather information from the University of Fort Hare community in the Eastern Cape province of South Africa.

Findings – The majority of the respondents had been exposed to warmed-over flavour before. More than half of the respondents did not know about antioxidants. Respondents were in support of the use of natural antioxidants in meat and meat products.

Research limitations/implications – The study mainly captured consumer habits based on living arrangements. Age influence could not be extrapolated due to the nature of the population, which was being studied. The population was limited to the University community, which is mainly made up of not so widely spread age groups and more or less similar levels of education. As a result, the findings and conclusions may not be a true reflection of the general public consumers in terms of age, level of education and employment status.

Originality/value – This research presents an original insight into consumer habits concerning the purchasing and storage of pre-cooked meat and meat products. The study revealed that most consumers nowadays prefer ready-to-eat or pre-cooked meat and meat products due to convenience. The warmed-over flavour is common in pre-cooked meats. The findings suggests that the meat industry has to improve the shelf-life of pre-cooked foods such that warmed-over flavour development is delayed to fit into the current consumer habits. In recent years there has been a growing interest in the use of natural antioxidants to improve shelf-life of muscle foods. However, there is a dearth of information on consumer attitudes towards the use of natural

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antioxidants as preservatives. This study reveals that consumers are willing to try products formulated using natural antioxidants.

Keywords Antioxidants, Consumers, Health, Ready-to-eat meats
Paper type Research paper

1. Introduction

Re-heating meat and meat products that have been pre-cooked and chill-stored results in the rapid development of distinctive off-flavours known as warmed-over flavour (WOF) (Byrne *et al.*, 2002). Cooking or thermal treatment boosts oxidation by facilitating tissue separation, which releases iron, and causes protein denaturation, inactivating antioxidant enzymes (Rojas and Brewer, 2007; Amaral *et al.*, 2018). The warmed-over flavour development is attributed to the auto-oxidation of meat lipids and has been commonly characterized as "stale," "wet," "cardboardy," "painty," "grassy," or "rancid" (Rojas and Brewer, 2007). In recent years, there has been a rapid increase in consumer demand for pre-cooked, ready-to-eat meat due to their effortless and time-saving preparation (Silberbauer and Schmid, 2017). However, ready-to-eat meat products have been reported to be more susceptible to the development of WOF (Byrne *et al.*, 2001; Johnston *et al.*, 2005). Warmed-over flavour is not acceptable to consumers (Iulietto *et al.*, 2015) and has been long recognized as a draw-back in the meat industry. Consequently, research on WOF development in meat has been of continuing interest to improve the quality of ready-to-eat meats and other convenience foods (Brøndum *et al.*, 2000; Jayathilakan *et al.*, 2007; Kim *et al.*, 2016).

Over the years, to minimize warmed-over flavour development and extending shelf-life, antioxidants have been used in the meat industry on products, such as meat patties, burgers and sausages (McCarthy *et al.*, 2001; Metsovas, 2013). The antioxidants being used are either derived from natural sources, such as plants, herbs and spices or synthetic sources, for example, Butylated hydroxytoluene (BHT) (Cömert and Gökmen, 2018). Synthetic antioxidants have, however, been reported to have negative effects on consumer health (Kumar *et al.*, 2015). Consequently, the search for more natural antioxidant sources has gained momentum in recent years (Shah *et al.*, 2014).

The overall aim of the meat industry is to satisfy and meet consumer needs and demands (Troy *et al.*, 2016). When a product fails to satisfy consumer expectations, the damage to producers goes beyond product replacement; it also includes the loss of the producer's reputation and future acceptance of the product (Brewer and Decker, 1998; Brewer, 2010). The use of natural antioxidants in the meat industry is relatively unexplored. Given the increasing interest in healthier meat and meat products incorporated with functional ingredients, lower sodium, lower calories and lower fat (Arihara, 2006), there is potential for the use of natural antioxidants in meat processing not only to improve shelf-life stability or inhibit warmed-over flavour but to also create a healthier image of the product. In order to use natural antioxidants to solve the problem of warmed-over flavour, a combination of consumer perceptions on the use of natural antioxidants, and an understanding of the prevalence of warmed-over flavour to consumers is critical for the meat industry. There is, however, scarcity on research that focuses on studying consumer habits that expose them to warmed-over flavour, and their attitudes towards the adoption of natural antioxidants in reducing the development of WOF. A better understanding of consumer exposure to WOF may help improve the competitiveness of the meat industry concerning the improvement of shelf-life in the development of meat and meat products. Therefore, this study seeks to assess the level of consumer exposure to warmed-over flavour, their habits that lead to warmed-over exposure and last their take on the use of natural antioxidants as preservatives.

2. Materials and methods

2.1 Study site description

The study was conducted at the University of Fort Hare, Alice, Eastern Cape Province of South Africa. The University of Fort Hare community has an estimated population of above 13,000. The University is located within a latitude of 320.47' South and longitude of 260.50` East of the Equator, with a mean altitude of 524 m (1,720 feet) above sea level.

2.2 Sampling method and data collection

Ethical clearance (Reference number MUCS11SLUN01) was granted by the University of Fort Hare Ethics Committee. Ethical considerations were observed during and after the data collection period. Respondents were sampled using the simple random sampling method. Check-All-That-Apply (CATA) design questionnaires were used to gather information from respondents. The questionnaires were organized into different sections comprising of questions on demographic characteristics (such as gender, age group, employment status and education), consumer habits of purchasing pre-cooked meat/meat products, the duration of keeping such products, previous experiences with warmed-over flavour, ability to describe the warmed-over flavour, knowledge of natural antioxidants and their take on the adoption of natural antioxidants in meat preservation. Warmed over flavour was defined to consumers using terms (painty, stale and cardboard-like) that were adopted from some descriptive terms used for evaluating oxidation flavours in meat (Rojas and Brewer, 2007). Consumers were then asked to describe the flavours they have sensed before from the listed terms. Five personnel were recruited and trained on how to administer the questionnaire and clarify to each respondent where questions were deemed not clear.

2.3 Statistical analysis

Frequencies for demographic information were computed using PROC FREQ procedures of SAS (2003). The XLSTAT 2016 software was used to perform correspondence analysis. Correspondence analysis was performed on the frequency table containing the "staying alone status and gender" on the rows against the "purchasing habits and storage habits" on the columns.

3. Results

3.1 Consumer demographic information

The demographic data of the consumers (Table 1) show that (52.94%) of the respondents were males. The most dominant age group was 18–35 years, making up (61. 34%) of the respondents followed by 36–50 years (30.25%), less than 18 years (5.46%) and last above 50 years (2.94%). More than half of the respondents (81.51%) had attended tertiary education

Characteristic	Category	Frequency	%
Gender	Male	112	47.06
	Female	126	52.94
Age	<18	13	5.46
	18–35	146	61.34
	36–50	72	30.25
	>50	7	2.94
Level of education	Tertiary	194	81.51
	Secondary	31	13.03
	Primary	13	5.46
Employment status	Unemployed	147	61.76
	Employed	91	38.24

Table 1. Demographic characteristics of the respondents ($n = 238$)

while the remaining proportions (13.03%) and (5.46%) had attended secondary ad primary education, respectively. Only (38.24%) of the respondents were employed and the rest were unemployed.

3.2 Consumer experience of warmed- over flavour

The warmed-over flavour was defined to all the respondents. The results (Figure 1) show that (88.66%) of the consumers had experienced the warmed-over flavour before. From the terms that were given to characterize warmed-over flavour, (36.97%) of the consumers described the warmed-over flavour they experienced as "stale," whereas (21.43%) and (2.86%) described the WOF as cardboard-like and painty, respectively. The remaining (38. 66%) were not sure of how to describe warmed-over flavour, as shown in Figure 2.

3.3 Respondents habits of eating pre-cooked meats and meat products and reasons for preferring pre-cooked meat and meat products

The habits of the consumers were analysed under the following categories (males living alone, males living with family, females living alone, and females living with family). The results (Figure 3) displayed that there were differences in the habits of consumers under different categories. From the results, the majority of males living alone indicated that they purchase pre-cooked meats at least weekly, while females living alone purchase fortnightly and last, males and females living with families purchase at least once a month. Results in Figure 4 show that more than half of the consumers (52.10%) indicated that they prefer pre-cooked meat and meat products because of their busy schedules while (41.18%) attributed the habit of buying of pre-cooked meat and meat product to convenience. The remaining (6.72%) had no reason for the habit.

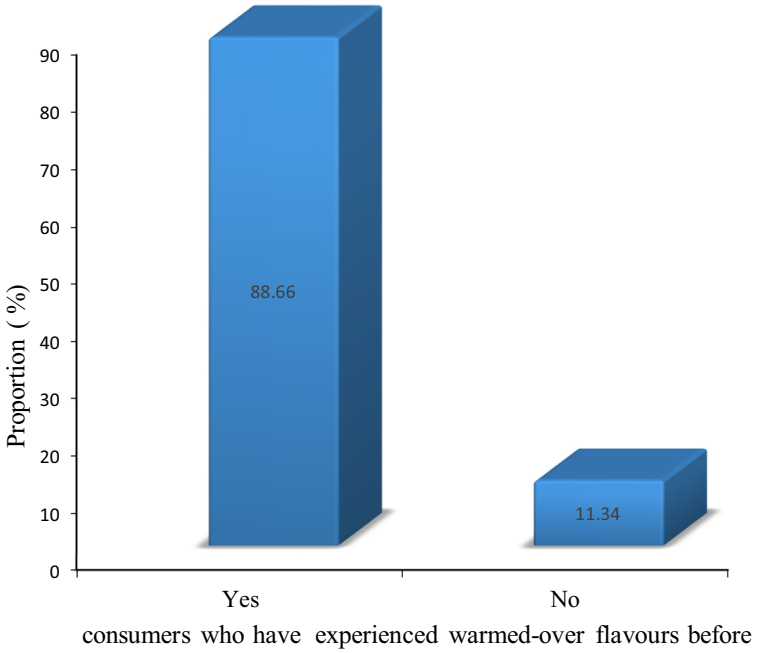

Figure 1.
Respondents' experiences of warmed-over flavour

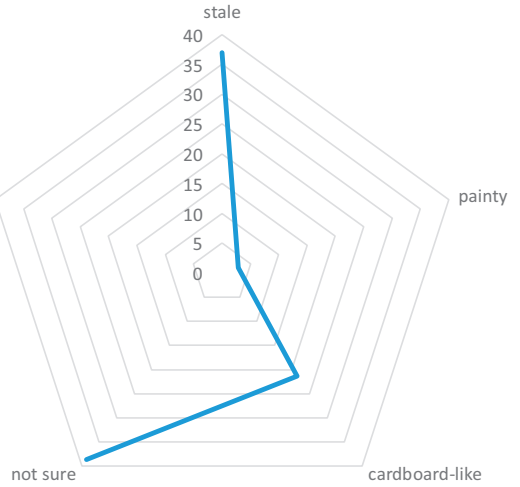

Figure 2.
Consumer description of warmed-over flavour

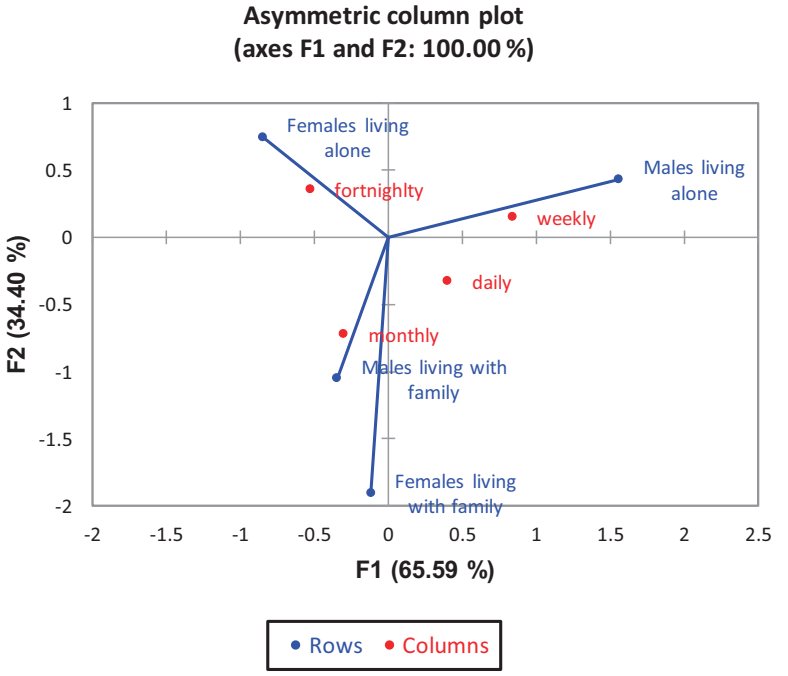

Figure 3.
Asymmetric plot representing the magnitude of different purchasing habits by the respondents under different categories.
Key:
Columns = purchasing habit;
Rows = category of consumer

3.4 Duration refrigerated storage (with subsequent re -heating and refrigeration), by consumers of pre-cooked meat and meat products

The length of time consumers kept pre-cooked meat or meat products for later use was not the same. The majority of the respondents (39.08%) indicated that they stored for less than 3 days while (31.93%) indicated that they never keep leftovers and the remaining (27.31%) and (1.68%) stored between six-nine days and above ten days respectively. As shown in

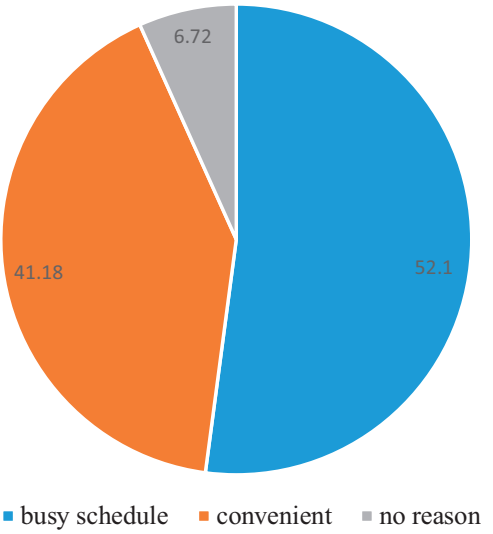

Figure 4.
Reasons for preferring pre-cooked meat and meat products

(Figure 5), the asymmetric plot indicates that the majority that stored from six to nine days were males living alone, while the majority of the females living alone stored for less than three days. Last, the majority of males and females living with families made up the proportion that never stores pre-cooked meat.

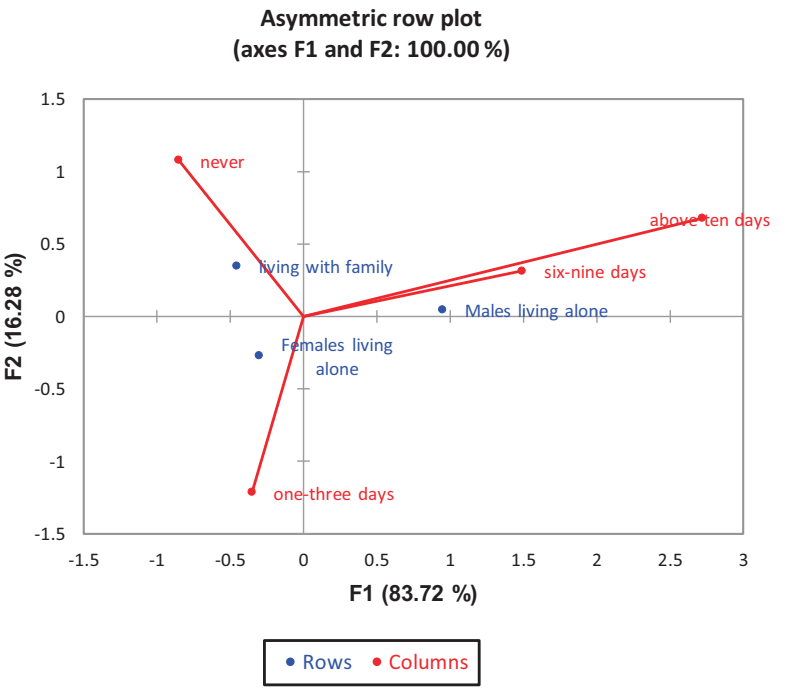

Figure 5.
Asymmetric plot representing the extent of pre-cooked meat storage for subsequent reheating. Key:
Columns = storage duration;
Rows = category of consumer

3.5 Consumer knowledge of antioxidants and their attitudes towards their (antioxidants) inclusion in meat preservation

The results of consumer knowledge of antioxidants and their attitudes towards their inclusion in meat preservation are shown (Figure 6). The results showed that (60.08%) of the consumers did not know what antioxidants are. From the respondents that knew about antioxidants, 73. 68% of them indicated that they had an idea about natural and synthetic antioxidants. More than half (66.32%) of the respondents that were aware of the two different classes of antioxidants had knowledge of the toxic health effects of synthetic antioxidants. When asked about their take of the use of natural antioxidants, the majority of the respondents (75.63%), including those that did not know about antioxidants, indicated that they would support more use of natural antioxidants.

4. Discussion

Findings from the current study showed that the majority of the respondents had experienced a warmed-over flavour before. This is in line with reports by Cross *et al.* (1987) and Byrene *et al.* (2001), who reported that warmed-over flavour development in pre-cooked meat was a major consumer concern. In support of the aforementioned, Lepper-Blilie *et al.* (2014) stated that consumer sensitivity to warmed-over flavour in pre-cooked beef is a major concern in the meat industry. The majority of the respondents in this study had a habit of purchasing pre-cooked, refrigerated heat-to-eat meat and meat products. The findings concur with recent reports stating that consumer demand for ready-to-eat or heat-to-eat pre-cooked meat products has increased (Byrne *et al.*, 2001; Ottar Olsen *et al.*, 2009; lepper-Blilie *et al.*, 2014; Janssen *et al.*, 2018). The patterns that were drawn from correspondence analysis further indicated that the majority of males and females that live alone were into the habit of purchasing pre-cooked meat compared to males and females that live with family. This could be attributed to convenience reasons as people who live alone may hardly prepare a home-cooked meal compared to those that live as families. According to some researchers, people who live alone may not be in the habit of cooking because there is no accountability to others; for males, the lack of interest or skills in cooking is a contributory factor to eating pre-cooked meals (Badore, 2015). This statement is in agreement with findings from this study, which showed that the majority of males and females living alone had a habit of storing pre-cooked

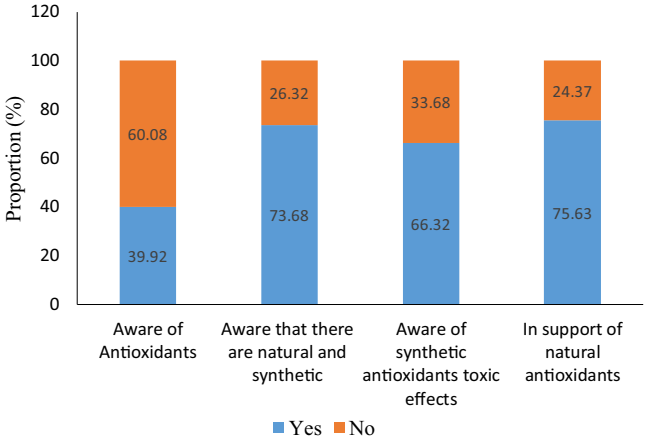

Figure 6.
Consumer awareness and knowledge on the use of natural and synthetic antioxidants

meats under refrigeration for later reheating (Figure 5) a habit, which exposes the meats to warmed-over flavour.

This study showed that most of the consumers attributed the habit of purchasing and storing pre-cooked meat and meat products to busy schedules and convenience reasons. The findings are in agreement with Bae *et al.* (2010), who reported that the biggest purchase motivator for pre-cooked ready-to-eat foods for most consumers was convenience. Reports by (Guthrie *et al.*, 2002) also support the notion that there is an increased prevalence of out-of-home eating as a habit because it is deemed "convenient" in terms of reduced demands in cleaning and preparation time.

Most of the consumers were not sure of how to define warmed-over flavour; this concurs with findings by Byrene *et al.* (2002), who reported that it is not clear how consumers detect warmed-over flavour. This calls for responsible consumer agencies to educate consumers on warmed-over flavour and how to detect them to avoid food poisoning, which is a critical food safety issue. Moreover, these are undesirable attributes that negatively affect consumer perception of a product. From the proportion that was able to describe the warmed-over flavour, the majority characterized it as stale, followed by cardboard-like and last painty. In previous researches, panelists have described warmed-over flavour as "stale," "wet," "cardboardy," "painty," "grassy" or "rancid" (Campo *et al.*, 2006; Rojas and Brewer, 2007).

Antioxidants have long been used in the meat industry to preserve meats to limit occurrences of meat deterioration, such as the development of warmed-over flavour. Regardless of this long known existence of antioxidants, findings from this study showed that more than half of the respondents were not aware of what antioxidants are and how they are used in meat preservation. The findings are in line with reports by Falowo (2015), who found that most consumers were not aware of the use of antioxidants as preservatives. This is further supported by Carocho *et al.* (2015), who stated that there is a lack of knowledge when it comes to distinguishing natural from synthetic compounds by the public. This lack of knowledge could be attributed to that the information about antioxidants is rarely conveyed to the public. The information that exists concerning antioxidants is usually found on the Internet, and not everyone has access to it. Moreover, antioxidants are not mentioned or advertised on meat labels (Venkatesh and Sood, 2011; Carocho *et al.*, 2015), and hence, consumers are not aware of them. From the proportion of the respondents that were aware of what antioxidants were, more than half of them indicated that they were aware of the toxic effects of synthetic additives. This is in line with recent reports stating that consumers are becoming health-conscious (Hoffman and Wiklund, 2006; Gramza-Michałowska *et al.*, 2016). There is, however, still a need to further raise consumer awareness on different classes of antioxidants, their uses and health effects because the majority is still not aware. This is in agreement with conclusions by Legesse *et al.* (2016), who mentioned that there is still a lack of knowledge among consumers concerning the health effects of food additives, which calls for more awareness activities in this regard. Unexpectedly, findings from this study had a greater proportion of consumers indicating that the meat industry should use more natural antioxidants. When informally asked why they would prefer natural antioxidants regardless of their knowledge of antioxidants some of the consumers stated that "I just saw the word natural, anything natural is good." This again confirms the current indications from research, which show that consumers are now demanding naturally produced meat products (Karre *et al.*, 2013; Gonzalez and Angeles, 2017) because most consumers have become health conscious. This is further supported by Carocho *et al.* (2014), who stated that normally, consumers would choose food without additives, but if it is not available, the same consumer may opt for food incorporated with natural additives over synthetic ones.

Various natural antioxidants have shown potential in limiting the development of warmed-over flavour in meat and this gives them the potential to be used in the meat industry to meet consumer demands of a healthy product.

5. Conclusions

The warmed-over flavour has long been recognized as a challenge in the meat industry and is still a problem to-date. This has been worsened by the increased number of consumers who are into convenience foods. These pre-cooked convenience meats are more susceptible to the development of warmed-over flavour. Most of the consumers relate their busy schedules and convenience to their habits of purchasing pre-cooked meat and meat products. The conclusions of this study must be interpreted bearing in mind that the studied group was limited to a university population, which was mainly made up of young, unemployed and highly educated people. Therefore, the results cannot be equated to what could have been found if the study was conducted in an area that encompasses the general public. From the patterns of consumers, it is quite evident that consumers are likely to experience warmed-over flavour in their day to day routines. The warmed-over flavour is a characteristic that is not acceptable to consumers. For ensuring the sustainability and competitiveness of the meat and meat processing industry in the development of healthy ready-to-eat pre-cooked meats and meat products, which meet consumer demands, it is the mandatory for the meat industry to continue exploring for more natural antioxidants. Consumers still need to be educated on the effects of synthetic antioxidants and the potential health benefits of natural antioxidants in meat preservation. The application of natural antioxidants in meat and meat products will not solely depend on the consumer decisions, but also relies on the combination of research output on the effectiveness of different potential natural antioxidants at different inclusion levels and the consumer acceptance of the final flavour of the product that has been preserved with natural antioxidants. This combination is a good start to reaching a consensus on how natural antioxidants can be practically adopted by the meat industry to meet the consumer demands for a healthy product.

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