JOURNAL OF CURRENT RESEARCH IN FOOD SCIENCE

E-ISSN: 2709-9385
P-ISSN: 2709-9377
JCRFS 2023; 4(2): 25-29

www.foodresearchjournal.com
Received: 15-04-2023
Accepted: 30-05-2023

Hardik Sharma
University Institute of Agricultural Sciences, Chandigarh University, Mohali, Punjab, India

Reshu Rajput
University Institute of Agricultural Sciences, Chandigarh University, Mohali, Punjab, India

Correspondence Author:
Hardik Sharma
University Institute of Agricultural Sciences, Chandigarh University, Mohali, Punjab, India

The science of food preservation: A comprehensive review of synthetic preservatives

Hardik Sharma and Reshu Rajput

Abstract
Food Preservatives are the supplementary substances that are added to the food and primarily serve in providing flavour and enhancing the shelf life of food, which consequently aids in avoiding the spoilage of food and protects it against microorganisms (such as bacteria, yeast, and moulds) as well as potentially fatal botulism and other organisms that can cause food poisoning (antimicrobial function). Antimicrobials like nitrates, nitrites, benzoates and sulphur dioxide help control and slow the growth of bacteria, yeast and moulds. Propyl gallate, butylated hydroxytoluene, and butylated hydroxy anisole are certain antioxidants required to halter fats and oils' degradation. Anti-enzymatic preservatives like Citric and erythorbic acids are also essential in protecting the food from ripening long after harvesting. Today, chemical preservatives are more commonly utilised than natural ones. A few of them are poisonous, and several others could have fatal adverse effects. According to research, artificial preservatives such as nitrates, benzoates, sulphites, sorbates, parabens, formaldehyde, BHT, BHA, and many more can lead to significant health risks like cancer, neurological damage with insights into their modes of action, safety considerations, and the shifting landscape of consumer preferences, this review paper offers a thorough overview of the science behind synthetic food preservatives. The introduction to the review explains the essential concepts of food preservation and the microbiological, enzymatic, and chemical processes that cause food to decay. There are several groups of synthetic preservatives, including antioxidants and antibacterial agents.

Keywords: Preservatives, antioxidants, antimicrobial, carcinogen, side effects of preservatives

Introduction
Preservatives are substances, either synthetic or natural, that are added to foods like fruits, vegetables, prepared foods, cosmetics, and pharmaceuticals to lengthen their shelf lives and preserve their quality and safety by preventing, delaying, or stopping microbial contamination, fermentation, acidification, and decomposition. Many types of meat, including hams and fish, are still preserved by salting. Jams and jellies are held as high-sugar solutions. Indian and Chinese Eastern Civilisations also employed spices to maintain their food. It was common practice to pickle vegetables in salt, vinegar, lemon juice or mustard oil to preserve them. Food preservation revolutionised in the early 19th century thanks to canning and pasteurisation; today's Sterilisation techniques include irradiation, filtration, and addition [Anand and Sati, 2013] [4].
It is crucial to improve food quality and safety. Since the beginning, man has improved diet and hunting techniques, domesticated animals and plants, used physical means to preserve food, and added molecules to food to change flavours or extend shelf-life (Schreiber *et al*.., 2019) [29]. Various ingredients have served essential purposes in a variety of foods across time, supplying a cheap, nutrient-dense, delectable, colourful, and safe food supply, with food additives and technological advancements playing crucial roles. Their usage in the food sector is vital because it enables loss reduction, quality improvement, shelf-life extension, the creation of new formulations, and standardisation, all of which help to satisfy the market's increasingly demanding requirements (Otasevic *et al*., 2020) [21].

The science behind food preservation
Food preservation is an essential component of the food industry since it guarantees that food products are always safe and edible. The shelf life of food products has been significantly extended by synthetic preservatives, which have been created and improved along with various preservation techniques. Multiple techniques are utilised to protect food from spoiling germs and increase shelf life, including heating, cooling, salting, drying, and synthetic chemicals (Riaz, 2019) [28].

Chemical preservatives are one of the first strategies for preserving food and preventing food spoilage among those widely utilised. Chemical preservatives contain the Development of germs like bacteria and fungi that can ruin food. Although chemical preservatives have successfully halted microbial Development and increased the shelf life of food goods, there is rising worry about their potential health risks (Shi *et al*., 2016) [33]. Despite having high antibacterial activity, chemical synthesised preservatives are banned because of their possible carcinogenicity. Finding natural, efficient, and secure food preservatives that can increase the safety of food products for decades and guard against chronic diseases has become more important and of increasing interest.

Synthetic Preservatives: An overview

Synthetic preservatives have long been used in the food industry to extend the shelf life of food, limit microbial activity and maintain the overall quality of the foods (Kanelaki *et al*., 2022) [12]. These chemical compounds are added to food products to prevent the Development of bacteria, yeast, and moulds, which can lead to food spoiling and degradation. Sodium benzoate, potassium sorbate, butylated hydroxy anisole, and butylated hydroxytoluene are a few of the regularly used synthetic preservatives (Liu *et al*., 2021) [18]. These artificial preservatives have been well-researched and used to prevent microbial Development while food is stored. They have succeeded in halting rotting, cutting down on the risk of contracting foodborne illnesses and maintaining the sensory qualities of food products.

Principal

Despite all the facts that these chemicals are not entirely safe, synthetic preservatives are used in the food industry as they can be operated as an antioxidant, raising the acidity of the food, lowering the amount of moisture in it, postponing ripening and inhibiting the bacterial Development [Ahamad, 2013] [2].

Classification of preservatives

They fall under Class I and II preservatives (Anurova *et al*., 2019) [5]. Class 1 preservatives include glucose, sugar, common salt, vinegar or acetic acid, dextrose, edible vegetable oil and honey. On the other hand, nitrites or nitrates of potassium and sodium are class II preservatives. Pickled meat, sorbic acid and its potassium, calcium, and sodium salts; calcium or sodium propionates; lactic acid and potassium, sodium, and calcium salts; acid, calcium phosphate, and nisin. To stop the growth of microorganisms in acidic foods like fruit juice, pickles and soft drinks, sodium benzoate is added to prevent spoilage. Acid Benzoic: Fruit juice, fizzy beverages, and pickles are preservatives. However, there should only be one kind of Class II preservative to be utilised in a particular food item since it harms those who consume them excessively, such as Sulfites, benzoates, and sorbates. The classification of both classes of preservatives is shown in Fig. 1.

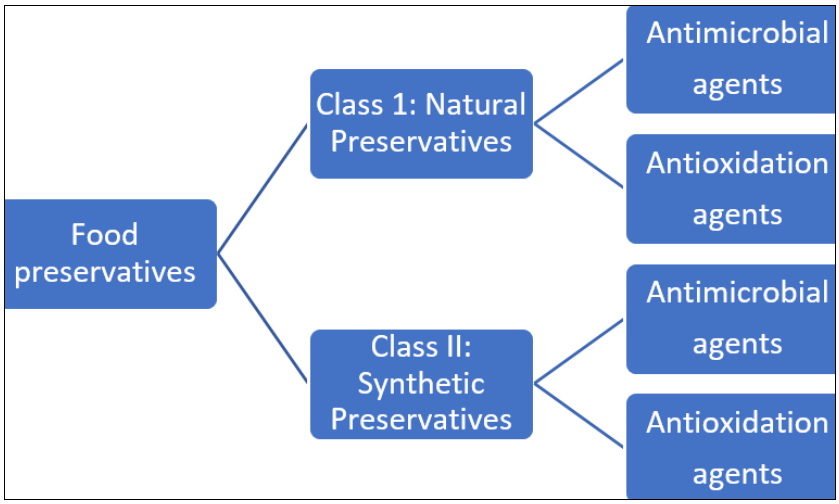

Fig 1: Categories of food preservatives

For example, nitrates and nitrites guard against food poisoning caused in meat products by bacteria. Antifungal substances like benzoates and sorbates are used to stop mould growth in cheese, pickles, jams and salad dressings.

Antioxidants reduce or stop the rancidity-causing breakdown of lipids and oils in food that takes place when oxygen is present. Antioxidants come in three different varieties (Yadav and Gupta, 2021) [26]

Table 1: Describes applications for preservatives.

Class	Preservatives	Application
Anti-microbial	Nitrates, nitrates, benzoates, sorbates, and sulphur dioxide.	Prevent the growth of bacteria, yeast, and moulds or slow it down.
Anti-oxidants	Ascorbic acid, butylated hydroxy anisole (BHA), and butylated hydroxytoluene (BHT).	To avoid rancidity, impede or stop the decomposition of fats and oils.
Anti-enzymatic	Erythorbic acid (ascorbic acid) and citric acid	Block the process during ripening and harvesting.

BHA and BHT are actual antioxidants. Ascorbic acid is a reducing agent. Sodium edetate is a synergistic antioxidant. Anti-enzymatic preservatives prevent enzymatic reactions like ripening in food even after harvest. Citric acid and erythorbic acid halt an enzyme's activity (Kulkarni, 2010) [16].

Table 2: Preservatives and the food products they can be used, together with their maximum permitted levels.

Preservatives	Max possible limit	Class	Optimum P.H	Product where they found	References
Citric Acid	200-350 ppm	Antienzymatic	pH 3.0-3.3	Cured meats, soft drinks, wines, juices	(Sharif, 2017) [32]
Sulfites and Sulphur dioxide	200-300 ppm	Antimicrobial	Acidic pH less than 4	Frozen or Fried Potatoes, molasses, dry fruits, and fruits	(Shi *et al*., 2016) [33]
Benzoic Acid and Benzoates (Sodium and potassium)	200 ppm	Antimicrobial	pH – 2.5-4	Fruit juice, Jams, Margarine, Pickles	[Ahamid, 2013] [2].
Nitrites and nitrates	100-200 ppm	Antimicrobial	-	Meat products	International Chemical Safety Card 0074
BHA and BHT	100 ppm	Antioxidants	pH- 4.8	Breakfast Cereals, meats, snacks, Baked foods	Anand and Sati, 2013) [4]
Propyl gallate	200 ppm	Antioxidants	-	Meats, baked foods	(Yadav and Gupta, 2021) [16]
Potassium Sorbates	200 ppm	Antimicrobial	pH-6.5	Bakery goods, syrups, fruit juices, sweets, dairy products	FDA/CFSAN Food Compliance Program: Domestic Food Safety Program

Health risks brought on by artificial preservatives

Many studies show that the synthetic preservatives used in various food goods seriously endanger consumers' health. Chemical preservatives frequently present in fruits, dairy products, confections, meats, and meat products, such as sugar, acids, and salts, have been linked to adverse effects on human health n (Matwiejczuk *et al*., 2020) [20].

Preservative use offers benefits and drawbacks of its own. The benefits of preservatives include preserving food quality and nutritional value, shielding it from microorganisms, and enhancing flavour. Their fault, on the other hand, is that they overconsume, which can result in illnesses like cancer, asthma, and kidney failure (Abdulmumeen *et al*., 2012) [1]. The risk of adverse health effects, such as allergic reactions and sensitivities, is one of the critical worries, especially in people with pre-existing diseases. People sensitive to or allergic to certain synthetic preservatives, such as sulphites, may experience adverse reactions. The potential for synthetic preservatives to be carcinogenic is another health risk. According to research, some artificial preservatives, including nitrites and nitrates, may interact with other substances in food to create nitrosamines, recognised carcinogens. Synthetic preservatives have the potential to cause cancer and allergy reactions, in addition to possibly being carcinogenic (Shafiqa-Atikah *et al*., 2020) [31]. The misuse and overuse of synthetic preservatives

Chemical Reactions of food and its preservatives

The precise number of reactions is still being determined because it is likely that many responses to food additives go undetected. However, according to several studies, the prevalence is probably lower than 1% of adults and as high as 2% of youngsters [Ahamid, 2013] [2]. Food additives have the potential to cause a wide variety of reactions. While many of these symptoms don't seem to be allergic but rather intolerable, some of them point to an allergic aetiology. The following responses to food additives have been reported: gastrointestinal, abdominal pain, nausea/vomiting, diarrhoea, respiratory, asthma symptoms, cough, rhinitis, musculoskeletal, muscle aches, joint aches, fatigue, weakness, neurologic, behaviour and mood changes, attention deficit and hyperactivity disorder, migraine headaches, numbness, cardiac (Inetianbor, JE *et al*., 2015) [16].

Sulphites are a common preservative found in many foods, and it is widely recognised that they can induce a wide range of symptoms. Nitrates and nitrites are additives that meat producers employ to cure the meat. There are a few nitrate and nitrite reactions, including urticaria, itching, and anaphylaxis. Benzoates are antimicrobial food preservatives that some people have reported worsening their asthma, allergic rhinitis, chronic urticaria, and flushing. Sorbates and sorbic acid are used as antibacterial preservatives in food. Although sorbate reactions are uncommon, reports of urticaria and contact dermatitis have been made (Hamid *et al*., 2012) [10].

Methodology: Several techniques have been found to determine the food preservatives. The suggested procedures like Calorimeter, Electrophoresis, UV-visible, and HPLC detect various preservatives in various foods (Lennerz *et al*., 2015) [17].

Regulatory guidelines for synthetic preservatives in food processing

The possible risks linked to the ongoing use of chemical synthetic preservatives in the food industry have recently come to light (Kim and Chevrier, 2020) [13]. Due in part to their carcinogenicity, this has resulted in the Development of regulatory rules and limitations on synthetic preservatives. For instance, only three of the 34 antimicrobial compounds the European Food Safety Authority licenced for food processing are natural; the other 32 are synthetic (Pahalagedara *et al*., 2022) [22]. Wild Substitutions for Artificial Preservatives Alternatives to Synthetic Preservatives in Natural Form There is growing interest in discovering natural preservatives that are efficient and safe for use in food processing due to the potential health problems connected with synthetic preservatives. Several natural preservatives have been researched and created as alternatives to artificial preservatives.

Plant extracts, essential oils, organic acids, and antimicrobial peptides are some natural substitutes. Various microorganisms, including bacteria, yeasts, and moulds, have been demonstrated to resist plant extracts' antibacterial activities. They contain bioactive substances that have antibacterial activity and can successfully stop the growth of germs in food products, such as phenolics, flavonoids, and terpenoids.

Consumer perception and response to synthetic preservatives

Consumers' view and reactions to synthetic preservatives in food products has significantly impacted the food business.

Customers are looking for preservative-free or minimally processed food options as their concerns about the possible adverse effects of synthetic preservatives on their health grow. Due to this tendency, the emergence of "green" consumerism and "clean labelling" has seen customers prioritise goods that they consider natural and devoid of artificial ingredients. Food producers have begun including natural preservatives in their products in response to this consumer demand (Külcü and Kalkan, 2022) [14]. These natural preservatives are frequently promoted as safer substitutes for synthetic preservatives and can help food products sell better.

The potential health concerns linked to synthetic preservatives are one of the key justifications for pursuing natural alternatives. It has been discovered that artificial food additives may be hazardous to human health and the environment, and they may have cancerous effects on living things. These worries have motivated academics and the food business to look into natural and less expensive alternatives that don't present toxicological issues and do not negatively influence the environment.

In place of synthetic preservatives, natural antibacterial substances have recently gained popularity in food processing (Winkelstroter *et al*., 2022) [34]. Due to their antioxidant and antibacterial qualities, these natural antimicrobial compounds made from plant extracts have attracted interest. Plant extracts are particularly intriguing as natural preservative substitutes since they contain many phenolic components (Alsubhi *et al*., 2022) [3]. Inhibiting lipid peroxidation in fatty foods and scavenging free radicals are two functions of phenolic compounds' antioxidant and antibacterial characteristics, which also help prolong food goods' shelf life. Natural plant extracts and oils, such as those from rosemary, oregano, thyme, and clove, have been demonstrated to have potent antibacterial properties against various foodborne pathogens, including bacteria, fungi, and moulds.

Potential drawbacks of synthetic preservatives

However, using artificial preservatives in food processing may have some adverse effects, which must be acknowledged. The fact that synthetic preservatives can cause mutations in species that are not their targets is a significant cause for worry. In some creatures, these substances have been discovered to result in genetic changes, which can hurt the ecosystem. In addition, using artificial preservatives may lead to environmental degradation (Shafiqa-Atikah *et al*., 2020) [31]. Excessive use of preservatives may lead to antibiotic resistance.

In addition, consumers' attitudes towards chemical preservatives have changed negatively, which has reduced their acceptability. There is a growing need for natural preservatives that can replace synthetic ones. Customers are demanding safer options as they become more aware of the possible health dangers linked to artificial preservatives. A rising market exists for natural preservative substances that can offer the same level of food safety without having the adverse health effects related to synthetic preservatives. In response to these worries, research into effective natural antibacterial agents that can replace artificial preservatives has increased (Maherani *et al*., 2017) [19].

The effect of preservatives on the liver

The liver is essential for creating antioxidants, regulating metabolic functions, and serving as the body's primary detoxification organ. Increased AST, ALP, and ALT are significant indicators of hepatic dysfunction brought on by adverse events, such as ingesting substances like butylparaben into the body (Boberg *et al*., 2010) [6]. Concern has been expressed recently regarding the potential adverse effects of chemical additions on kidney and liver function. The use of parabens by people daily is widely accepted by the food, cosmetic, and drugstore industries (Fontenele *et al*., 2019) [7-8]. Abuse of synthetic preservatives causes numerous adverse effects on the liver tissue, such as hepatocytes losing inflammatory macrophage.

Effect of Preservatives on body weight

Parabens are endocrine disruptors that change the expression of adipocyte-related genes and may make them build up in fatty tissues. Lipogenesis in adipose tissue is modified using mesenchymal stem cells for the adipocyte lineage, supporting the Development of obesity (L. Quirós-Alcalá *et al*., 2018) [24]. A study conducted *in vitro* has shown that parabens support Adipocyte differentiation and an increase in obesity. Also, Hormone disruption is a factor in physical transformation. Parabens balance weight and energy, which is crucial in the emergence of metabolic syndrome and lower testosterone levels. The hormone significantly affects oestrogen levels.

Conclusion

Synthetic Preservatives in the Modern Food Industry.

As a result of increasing the shelf life of perishable foods and assuring their microbiological and oxidative stability, synthetic preservatives have substantially impacted the food processing sector. However, there are issues with using artificial preservatives due to the rising desire for natural and clean-label additives. These difficulties include concerns about potential health dangers and environmental contamination from synthetic preservatives. Synthetic preservatives nonetheless have a place in the food sector despite these difficulties. Future trends for artificial preservatives include the creation of substitutes that are thought to be safer and more ecologically friendly, as well as the application of nanotechnology.

The search for natural alternatives to synthetic preservatives is driven by concerns about the potential health risks and environmental pollution associated with these compounds. Consumers are increasingly seeking food products with clean-labelling and are more inclined to choose natural additives over synthetic). In response to this demand, the food industry is exploring future trends in artificial preservatives. One of these trends is the Development of alternative artificial preservatives perceived as safer and more environmentally friendly. These new synthetic preservatives undergo extensive testing to ensure they are non-toxic and have minimal environmental impact. Additionally, nanotechnology is emerging as a promising approach to developing artificial preservatives. Nanotechnology allows for the creation of nano-sized particles that can be incorporated into food packaging materials, providing antimicrobial properties and extending the shelf life of the products. Overall, the food industry needs to balance the use of synthetic preservatives and the demand for natural alternatives.

References

1. Abdulmumeen HA, Ahmed NR, Agboola RS. Food: its preservatives, additives and applications. Int'l J. of chemical and Biochemical sciences. 2012;1:36-47.

2. Ahmed N. Naturally occurring preservatives in food and their role in food preservation. International Journal of Pharmaceutical & Biological Archive. 2013;4(1):22-30.
3. Alsubhi NH, Al-Quwaie DA, Alrefaei G, Alharbi M, Binothman N, Aljadani M, *et al*. Pomegranate Pomace Extract with Antioxidant, Anticancer, Antimicrobial, and Antiviral Activity Enhances the Quality of Strawberry-Yogurt; c2022.
4. Anand SP, Sati N. Artificial preservatives and their harmful effects: looking toward nature for safer alternatives. International Journal of Pharmaceutical Sciences and Research. 2013;4(7):2496.
5. Anurova MN, Bakhrushina EO, Demina NB, Panteleeva ES. Modern preservatives of microbiological stability. Pharmaceutical Chemistry Journal. 2019;53(6):564-571.
6. Boberg J, Taxvig C, Christiansen S, Hass U. Possible endocrine disrupting effects of parabens and their metabolites. Reproductive Toxicology. 2010;30(2):301-312.
7. Fontenele E, Quezado R, Bachega TS. Testosterone and Endocrine Disruptors: Influence of Endocrine Disruptors on Male Reproductive Tract. In Testosterone Springer, Cham; c2017. p. 353-374.
8. Fontenele E, Quezado R, Bachega TS. Testosterone and Endocrine Disruptors: Influence of Endocrine Disruptors on Male Reproductive Tract. In Testosterone Springer; c2017. p. 353-374.
9. Food and Drug Act of Section. 1906;402(a)(1)
10. Hamid AA, Ahmed NR, Agboola RS. Food: Its preservatives, additives and applications. International Journal of Clinical and Biological Sciences. 2012;1:36-47
11. Inetanbor JE. Effects of food additives and preservatives on man: Asian Journal of Science and Technology. 2015;6(02):1118-1135.
12. Kanelaki A, Zampouni K, Mourtzinos I, Katsanidis E. Hydrogels, Oleogels and Bagels as Edible Coatings of Sardine Fillets and Delivery Systems of Rosemary Extract; c2022.
13. Kim J, Chevrier J. Exposure to parabens and prevalence of obesity and metabolic syndrome: An analysis of the Canadian Health Measures Survey. Science of the Total Environment. 2020;713:135116.
14. Külcü DB, Kalkan S. Modelling the Microbial Shelf-Life of Chicken Mince Added Rosemary Extract; c2022. https://scite.ai/reports/10.1590/1678-4324-2022200801
15. Kulkarni C, Deshpande A, More S. Assessment of microbial contamination in commercial herbal oral medicinal liquids. Int J Pharm Res Dev. 2010;2(9):191-193.
16. Kulkarni SK, Dhir A. An Overview of Curcumin in Neurological Disorders. Indian Journal of Pharmaceutical Sciences. 2010;72:149-154.
17. Lennerz BS, Vafai SB, Delaney NF, Clish CB, Deik AA, Pierce KA, *et al*. Effects of sodium benzoate, a widely used food preservative, on human glucose homeostasis and metabolic profiles. Molecular genetics and metabolism. 2015;114(1):73-79.
18. Liu J, Huang R, Song Q, Xiong H, Ma J, Xia R, *et al*. Combinational Antibacterial Activity of Nisin and 3-Phenyllactic Acid and Their Co-production by Engineered Lactococcus lactis; c2021.
19. Maherani B, Harich M, Salmieri S, Lacroix M. Comparative evaluation of antimicrobial efficiency of FOODGARD F410B citrus extract and sodium benzoate against foodborne pathogens in strawberry filling; c2017.
20. Matwiejczuk N, Galicka A, Zaręba I, Brzóska MM. The protective effect of rosmarinic acid against the unfavorable influence of methylparaben and propylparaben on collagen in human skin fibroblasts. Nutrients. 2020b;12(5):1282.
21. Otasevic V, Stancic A, Korac A, Jankovic A, Korac B. Reactive oxygen, nitrogen, and sulfur species in human male fertility. A crossroad of cellular signalling and pathology. Biofactors. 2020;46(2):206-219.
22. Pahalagedara ASNW, Flint S, Palmer JW, Brightwell G, Gupta TB. Antibacterial efficacy and possible mechanism of action of 2-hydroxyisocaproic acid (HICA); c2022.
23. Pandey RM, Upadhyay SK. Food additives, Food Additives prof. Yehia El-mmsamragy (Ed.), ISBN:978-95; c2012.
24. Quirós-Alcalá L, Buckley JP, Boyle M. Parabens and measures of adiposity among adults and children from the U.S. general population: NHANES 2007–2014. International journal of hygiene and environmental health. 2018;221(4):652-660.
25. Quirós-Alcalá L, Buckley JP, Boyle M. Parabens and measures of adiposity among adults and children from the US general population: NHANES 2007–2014. International Journal of hygiene and environmental health. 2018;221(4):652-660.
26. Yadav RK, Gupta R. Department of Chemistry, Dr. C.V. Raman University, Kargi Road Kota, Bilaspur (C.G.), 2021, 495113.
27. Rayasam SD, Koman PD, Axelrad DA, Woodruff TJ, Chartres N. Toxic Substances Control Act (TSCA) Implementation: How the Amended Law Has Failed to Protect Vulnerable Populations from Toxic Chemicals in the United States. Environmental Science & Technology; c2022. https://doi.org/10.1021/acs.est.2c02079
28. Riaz A. Characterisation of Bacteriocin-like Inhibitory Substances from Enterococcus ratti MF183967; c2019.
29. Schreiber E, Garcia T, Sharma RP, Torrente M, Domingo JL, Gómez M. Oxidative stress in testes of rats exposed to nbutylparaben. Food and Chemical Toxicology. 2019;131:110573.
30. Seetaramaiah K, Anton Smith A, Murali R, Manavalan R. Preservatives in Food Products- Review. Int J Pharm Biol- Arch. 2011;2:583-599.
31. Shafiqa-Atikah MK, MAR, N, Mahyudin NA, Abas F, Nur-Syifa' J. Evaluating sugarcane molasses' phenolic constituent, antioxidant and antibacterial activities towards foodborne pathogens; c2020.
32. Sharif ZIM, Mustapha FA, Jai J, Yusof NM, Zaki NAM. Review on methods for preservation and natural preservatives for extending the food longevity. Chemical Engineering Research Bulletin. 2017;19:145-153.
33. Shi C, Zhao X, Liu Z, Meng R, Chen X, Guo N. Antimicrobial, antioxidant, and antitumor activity of epsilon-poly-L-lysine and citral, alone or in combination; c2016.
34. Winkelstroter LK, Bezirtzoglou E, Tulini FL. Editorial: Natural Compounds and Novel Sources of Antimicrobial Agents for Food Preservation and Biofilm Control; c2022.