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Application of Anthocyanin Extract from Purple Sweet Potato (*Ipomoea batatas L.*) as a Natural Indicator for Borax Detection in Puli Crackers

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ABSTRACT

Introduction: Food safety remains a major public health concern because contaminated food may cause adverse health effects, including poisoning from prohibited additives such as borax. Borax is illegally added to improve texture and shelf life despite its known toxicity. Puli crackers, a traditional snack widely consumed in Makassar City, are suspected of containing borax. This study aimed to detect borax in puli crackers using anthocyanin extract from purple sweet potato (*Ipomoea batatas L.*) as a natural colorimetric indicator.

Methods: This research employs an observational method with a descriptive approach. A total of 21 puli cracker samples were purposively collected from five production sites and 16 street vendors. Samples were aseptically packaged in sterile polyethylene bags, labeled, and transported to the laboratory within 24 hours. In the laboratory, samples were homogenized, and aliquots were subjected to qualitative colorimetric analysis using anthocyanin extract to detect the presence of borax based on observable color changes. Borax detection was performed at the Chemistry Laboratory of Poltekkes Kemenkes Makassar using filter paper infused with purple sweet potato anthocyanin extract. A standardized borax test kit was used as a confirmatory method.

Results: All samples tested positive for borax, indicated by bluish-green to blue color changes and confirmed by the test kit. Sample pH values ranging from neutral to alkaline (7–9), with alkaline values supporting borax presence, with alkaline values supporting borax presence.

Conclusion: The findings highlight the urgent need for stricter regulatory monitoring of food production and distribution by relevant authorities. Enhanced education and outreach to producers and street vendors regarding the health risks of borax are also essential. Consumers are encouraged to be more vigilant in selecting food products and to recognize signs of potential borax contamination to reduce exposure risks.

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INTRODUCTION

Food safety is a fundamental public health issue, as the consumption of unsafe food can lead to various diseases, including food poisoning. In an era of globalized food production and distribution, food safety concerns extend beyond local boundaries and may pose international public health challenges (1). Ensuring the safety and quality of food is therefore essential to protect population health and improve overall quality of life (2). In Indonesia, food poisoning remains a significant concern. Data from the Indonesian Food and Drug Authority (BPOM) reported 265 cases of food poisoning in 2019 related to processed food from households or home industries, with oral consumption identified as the main exposure route (3). At the regional level, the Makassar BPOM Center documented 23 cases of food poisoning in 2021 associated with unsafe food consumption. These incidents are primarily attributed to bacterial contamination and the presence of hazardous chemical substances, which are exacerbated by inadequate supervision and the high consumption of ready-to-eat snacks within the community (4).

In Makassar City, one of the most widely consumed snacks is crackers, particularly *puli* crackers or rice crackers. These crackers are popular due to their distinctive taste and crunchy texture. However, there are indications of borax use in their production, often noticeable through a more vibrant color, fluffier texture, and a slightly bitter aftertaste (5). Due to the high consumption of puli crackers, some producers and traders tend to misuse food additives, including borax, to extend shelf life and enhance the appearance of their products (6). This misuse may occur either due to a lack of knowledge among producers or as a deliberate attempt to increase profits (7). Exposure to unsafe food additives, such as borax, can lead to serious health issues, including damage to the liver, cardiovascular system, central nervous system, peripheral nervous system, hematological system, urinary system (kidneys, ureters, bladder), and endocrine system (8). Foods contaminated with borax are difficult to distinguish visually, requiring laboratory testing for confirmation (9). However, alternative detection methods using natural ingredients are being developed, including those that utilize anthocyanin-containing natural indicators (8).

The misuse of food additives (BTP) that do not comply with regulations remains a significant issue in Indonesia. One of the most common cases is the use of borax as a food additive, even though this substance should only be used in the textile and household cleaning industries (10). Borax is often added to food products such as meatballs and rice cakes to enhance their chewy texture and extend shelf life. In crackers, borax can make the product crispier, more durable, and visually more appealing (11). However, borax containing foods are difficult to distinguish with the naked eye, making laboratory testing essential for detection(12). The consumption of borax-contaminated food in high doses around 10-20 g/kg of adult body weight or 5 g/kg of child body weight can cause poisoning and even lead to death (13). Study on borax analysis using butterfly pea flower extract in puli crackers found that 3 out of 8 samples tested positive for borax, indicated by a color change. This finding suggests that natural detection methods can be utilized to identify borax in food (14).

One natural ingredient that contains anthocyanins is purple sweet potato (15). Purple sweet potato (*Ipomoea batatas* L.) is a cultivated plant with tuberous roots that have high nutritional content, primarily carbohydrates (16). Besides being used as a food source and natural coloring agent, purple sweet potato also has a high anthocyanin content (17). Anthocyanins are natural pigments frequently utilized as indicators for borax detection in food owing to their pH-responsive color changes. However, existing research highlights methodological inconsistencies, including differences in extraction techniques, indicator stability, and interactions with complex food matrices, which limit comparability and reproducibility across studies (18).

Based on the study on the analysis of borax content in food using purple sweet potato extract at Karuwisi Market in Makassar, it was found that 7 out of 15 tested samples contained borax. These results indicate that purple sweet potato can serve as an effective natural indicator for detecting the presence of borax in food (19). The use of food additives that do not comply with regulations, such as borax in food, poses serious health risks. Borax is not intended for human consumption but is more commonly used in the textile and household cleaning industries (20). Long term consumption of borax can lead to various health issues, ranging from gastrointestinal irritation to systemic effects such as kidney, liver, and brain damage (21). In this context, the present study seeks to address this gap by applying an anthocyanin based detection method derived from purple sweet potato to identify the presence of borax in puli crackers circulating in Makassar City. By emphasizing methodological feasibility, accessibility, and applicability for preliminary screening, this study aims to complement existing laboratory-based techniques rather than replace them. The findings are expected to contribute to the development of simple, low-cost, and environmentally friendly screening tools for food safety monitoring, while simultaneously supporting regulatory efforts and public awareness regarding the risks associated with prohibited food additives.

METHOD

This research employs an observational method with a descriptive approach, collecting data through observation and determining borax content through laboratory examination. The sample collection locations for this study include production sites/frying locations in Bara-Baraya Timur, Makassar District, Abu Bakar Lambogo District, Makassar District, and street vendors operating in Cendrawasih District, Mamajang District, Tinumbu District, Bontoala District, Todopuli Raya District, Panakkukang District, and Bumi Tamalanrea Permai District. The sample analysis for borax detection was conducted at the Chemistry Laboratory of the Environmental Health Department, Poltekkes Kemenkes Makassar. The research took place from January to September 2023. The study population includes nine production/frying locations and 30 street vendors selling puli crackers. The samples were selected using purposive sampling, considering that puli crackers are a highly consumed and popular type of cracker. A total of 21 samples were collected, consisting of five samples from production/frying sites and 16 samples from street vendors in Makassar City. The data obtained from laboratory examinations were processed using a computer and presented in tables with supporting theoretical explanations. The data were analyzed descriptively, ensuring accuracy and completeness in documenting laboratory findings to derive valid conclusions. The results were then evaluated to determine whether the puli crackers sold in the market contained borax, in accordance with Minister of Health Regulation No. 2 of 2023 on Chemical Quality Standards for Borax in Processed Ready to Eat Foods.

Sample collection was conducted at production/frying sites located in Bara-Baraya Timur and Abu Bakar Lambogo districts, as well as from street vendors operating in Cendrawasih, Mamajang, Tinumbu, Bontoala, Todopuli Raya, Panakkukang, and Bumi Tamalanrea Permai districts, Makassar City. Laboratory analyses were performed at the Chemistry Laboratory of the Environmental Health Department, Poltekkes Kemenkes Makassar. The study was carried out from January to September 2023.

The study population consisted of nine production/frying locations and 30 street vendors selling puli crackers. Samples were selected using purposive sampling based on the high consumption and widespread availability of puli crackers in the study area. A total of 21 samples were collected, comprising five samples from production/frying sites and 16 samples from street vendors. Each sample was aseptically packaged in sterile polyethylene bags, properly labeled, and transported to the laboratory for analysis.

Purple sweet potato (*Ipomoea batatas L.*) tubers were washed, peeled, and cut into small pieces. Anthocyanins were extracted by maceration using an acidified ethanol based solvent (ethanol:distilled water, 70:30 v/v) at room temperature for 24 hours. The extract was then filtered using whatman filter paper to remove solid residues. The filtrate was stored in amber containers at 4 °C to minimize pigment degradation prior to use. Filter paper strips were immersed in the prepared anthocyanin extract for approximately 10 minutes to ensure uniform absorption. The impregnated papers were air dried at room temperature under dark conditions to maintain anthocyanin stability. The dried indicator papers were stored in airtight containers until analysis. For qualitative borax detection, a small portion of each puli cracker sample was moistened with distilled water. The anthocyanin infused indicator paper was then applied directly to the sample surface. Borax presence was determined based on observable color changes of the indicator paper, with bluish-green to blue coloration indicating a positive result. pH measurements were conducted to support the interpretation of borax-related alkalinity.

To validate the results obtained from the anthocyanin-based indicator, a standardized commercial borax test kit was used as a confirmatory method. The test kit employed in this study was manufactured by CHEM – KIT and designed for qualitative borax screening in food products. The kit operates on a colorimetric reaction principle between borax and a proprietary reagent, producing a characteristic color change in positive samples. Laboratory findings were recorded and tabulated, then analyzed descriptively to summarize detection patterns across sampling locations. The results were evaluated against the Indonesian Minister of Health Regulation No. 2 of 2023 concerning Chemical Quality Standards for Borax in Processed Ready to Eat Foods. Data processing was conducted using computer based tools to ensure accuracy and completeness of documentation.

Ethical Approval

This study has been approved by the Health Research Ethics Committee of Poltekkes Kemenkes Makassar (Approval Number: 0668/M/KEPK-PTKMS/VII/2023). All participants, including parents or guardians for participants under 18 years of age, provided informed consent before participating in this study. Confidentiality of all participants was strictly maintained throughout the research process.

RESULTS

In this study, borax testing was conducted on 21 cracker samples, specifically puli crackers, which were collected from five production/frying locations and 16 street vendors. The results are presented as follows:

Table 1. Qualitative Borax Detection and pH Characteristics of Puli Crackers Collected from Production/Frying Locations

No	Sampling Location	pH Value	Borax Detection Result	Color Response
1	TP I	8	Positive	Bluish green
2	TP II	9	Positive	Bluish green
3	TP III	8	Positive	Bluish green
4	TP IV	9	Positive	Bluish green
5	TP V	9	Positive	Blue

Table 1 highlights a uniform pattern of borax detection across all five production/frying locations, characterized by consistently alkaline pH values within a narrow range (8–9). This limited pH variability, together with homogeneous bluish-green to blue color responses of the anthocyanin-infused indicator, suggests a systematic rather than incidental use of borax at the production stage. The absence of pronounced pH differences among production sites indicates comparable processing practices, which may contribute to the consistent downstream detection of borax in products distributed to street vendors. These findings imply that borax contamination likely originates at the production level rather than arising from isolated handling or storage practices at the point of sale.

Table 2. Qualitative Borax Detection and pH Test Results for Puli Crackers from Street Vendors in Makassar City

No	Sampling Location	pH	Borax Detection Result	Color Response
1	PK I	8	Positive	Blue
2	PK II	7	Positive	Bluish Green
3	PK III	9	Positive	Blue
4	PK IV	8	Positive	Bluish Green
5	PK V	9	Positive	Blue
6	PK VI	7	Positive	Bluish Green
7	PK VII	7	Positive	Bluish Green
8	PK VIII	8	Positive	Bluish Green
9	PK IX	8	Positive	Bluish Green
10	PK X	8	Positive	Bluish Green
11	PK XI	8	Positive	Bluish Green
12	PK XII	8	Positive	Bluish Green
13	PK XIII	8	Positive	Blue
14	PK XIV	8	Positive	Blue
15	PK XV	8	Positive	Bluish Green
16	PK XVI	7	Positive	Bluish Green

Table 2 shows that all 16 samples collected from street vendors tested positive for borax when examined at the Chemistry Laboratory of the Environmental Health Department, Poltekkes Kemenkes Makassar. The pH testing results ranged from 7 to 9, with the presence of borax indicated by color changes on the filter paper used for detection.

DISCUSSION

Crackers are a popular food with a high consumption rate. This product is easily found in various places, ranging from small food stalls to supermarkets (22). One of the most popular types of crackers in Makassar City is *puli* crackers or rice crackers. These crackers have a distinctive taste and crunchy texture that are favored by the community. This study found indications of borax use in *puli* crackers circulating in Makassar City. Laboratory examination indicated that all 21 puli cracker samples produced positive borax responses using anthocyanin-based qualitative colorimetric testing. Although the method does not provide quantitative concentration data, the uniformity of positive results across samples from both production sites and street vendors supports the robustness of the observed findings. This finding indicates that the use of borax in *puli* cracker production is still occurring. The tested samples showed a color change on the filter paper containing purple sweet potato extract, turning blue and bluish-green, indicating the presence of borax. This result was further confirmed by the commercial borax test kit produced the characteristic positive color reaction specified by the manufacturer. These findings suggest that *puli* crackers do not meet the requirements stipulated in Minister of Health Regulation No. 2 of 2023 on Chemical Quality Standards for Borax in Processed Ready to Eat Foods.

The color change observed in the purple sweet potato extract filter paper is due to the amphoteric properties of anthocyanins, which can react with both acidic and alkaline environments. In an acidic environment, anthocyanins appear red, while in an alkaline environment, they turn purple or blue (23). The pH test results for *puli* cracker samples showed a tendency toward alkalinity, which aligns with the observed color changes. This pH value indicates that *puli* crackers have an alkaline nature, a characteristic commonly found in foods containing borax (24).

Anthocyanins are pH-sensitive pigments whose molecular structure changes under acidic and alkaline conditions, meaning they can react with both acids and bases, with a potential anthocyanin content of 560 mg/100 g (25). This pH-responsive behavior underpins their applicability as colorimetric indicators for detecting alkaline substances such as borax. However, findings from this and previous studies suggest that the continued detection of borax in non-meat products, including crackers, may be partly driven by persistent misconceptions among food producers and vendors who assume that borax is only relevant as a preservative for meat-based products such as meatballs. Similar misconceptions have been documented in the broader food safety literature, where limited knowledge, economic pressures, and inadequate risk perception are identified as key behavioral determinants influencing the misuse of prohibited food additives. Within this context, the application of anthocyanin-based indicators not only serves an analytical function but also highlights an educational gap in food safety awareness, emphasizing the need for integrated approaches that combine accessible detection tools with targeted risk communication and behavioral interventions (26). The results of this study indicate that the color change observed in the purple sweet potato extract filter paper aligns with the pH values of the samples, which tend to be alkaline, reinforcing the indication of borax presence in puli crackers. This finding is also supported by previous research showing that borax can increase the pH of food due to its alkaline properties (27). This confirms that pH testing can be used as a supporting method for detecting borax in food, especially when combined with natural indicators such as anthocyanins from purple sweet potato. This finding is consistent with the study which demonstrated that purple sweet potato extract is effective in detecting borax in food (28).

Borax is a chemical compound widely used in non-food industries such as textiles, detergents, and cosmetics; however, its application in food is strictly prohibited due to well-documented health risks. Acute exposure to borax may cause gastrointestinal irritation, vomiting, diarrhea, and neurological disturbances, while chronic exposure has been associated with renal and hepatic impairment, reproductive toxicity, and central nervous system disorders (29). In this study, the detection of borax in all analyzed samples indicates a potential continuous exposure risk for consumers, particularly given the frequent consumption of crackers as a household snack. From a methodological perspective, the observed colorimetric responses are consistent with the chemical behavior of anthocyanins, which exhibit red coloration under acidic conditions and shift toward blue hues in alkaline environments such as those associated with borax-containing foods. Similar anthocyanin-based detection approaches have been reported in previous studies using plant sources such as butterfly pea flower and purple sweet potato, demonstrating comparable qualitative sensitivity for borax screening (30). However, prior research also highlights that food matrix characteristics including starch content, moisture level, residual oils, and the presence of alkaline additives other than borax may influence color intensity and visual interpretation (31). Therefore, while the consistent alkaline pH and uniform color changes observed in this study support the reliability of the anthocyanin indicator, potential matrix effects and interfering substances should be considered when interpreting colorimetric outcomes, underscoring the importance of confirmatory testing for comprehensive food safety assessment (32).

Another finding from this study shows that most vendors source their raw cracker materials from outside Makassar City, such as Gowa and Maros, before frying and selling them. A brief interview with the vendors revealed that many of them were unaware that borax was also used in cracker production. Some assumed that borax was only used as a preservative in meatballs. This highlights the need for increased education for producers and vendors regarding the dangers of borax use in food. Borax containing crackers have distinctive characteristics, such as a crispier texture, a more savory taste, and a longer shelf life without becoming stale. Consuming crackers that contain borax can cause a bitter aftertaste on the tongue and dryness in the throat after consumption (33). The misuse of borax is generally intended to extend product durability and improve texture, but it fails to consider the potential health risks to consumers (34).

Beyond reinforcing existing knowledge on the risks of borax and the availability of permitted alternatives such as sodium tripolyphosphate, this study contributes methodologically by demonstrating the feasibility of anthocyanin-based colorimetric indicators as a low-cost, plant-derived screening approach for detecting prohibited additives in processed foods (35). Unlike conventional laboratory-intensive analyses, the proposed approach highlights the potential of natural indicators for preliminary surveillance and routine field-level monitoring (36). From a scientific perspective, these findings support the conceptual advancement of integrating natural pigment chemistry into food safety assessment frameworks, particularly in settings with limited analytical infrastructure (37). This methodological perspective complements regulatory efforts by providing an accessible tool that may enhance early detection and risk communication related to hazardous food additives.

This study has several limitations that need to be considered. The number of samples examined was relatively small, with only 21 puli cracker samples collected from selected locations, which may not fully represent all products circulating in Makassar City. The detection method using purple sweet potato anthocyanin indicators and pH testing was semi-qualitative, allowing confirmation of borax presence but not its exact concentration, as more advanced quantitative tests were not conducted due to resource constraints. In addition, the pH values obtained may be influenced by other factors such as frying conditions or storage, making them a supporting indicator rather than a definitive measure. The brief interviews conducted with vendors also provided limited information regarding production practices and knowledge about borax use, as producers themselves were not directly assessed. Environmental factors such as temperature and humidity during storage were also not controlled, which may influence sample characteristics. Despite these limitations, the findings still provide valuable evidence that borax use in puli crackers remains prevalent and requires immediate attention from relevant authorities.

CONCLUSION

This study demonstrates the applicability of anthocyanin extract as a natural, qualitative indicator for borax detection in puli crackers, revealing a consistent presence of borax across samples obtained from both production sites and street vendors. Beyond its regulatory implications, these findings contribute to the growing body of evidence supporting the use of plant-based colorimetric indicators as accessible screening tools for food safety monitoring. The uniform detection results across different sources suggest the method's potential robustness for preliminary surveillance, particularly in resource-limited settings. While the analysis was qualitative in nature, the study highlights the need for further quantitative validation and standardization of anthocyanin-based indicators to enhance analytical reliability. In this context, strengthened regulatory supervision and targeted education for food producers, vendors, and consumers remain essential to reduce the circulation of borax-contaminated foods.

AUTHOR'S CONTRIBUTION STATEMENT

Zaenab contributed to the conception and design of the research, conducted field sampling and laboratory analysis, performed data interpretation, and was responsible for drafting and revising the manuscript. She ensured the accuracy and integrity of all aspects of the study and approved the final version for publication.

CONFLICTS OF INTEREST

The author declares no conflicts of interest. There are no financial or personal relationships with individuals or organizations that could have inappropriately influenced the conduct or outcomes of this research.

DECLARATION OF GENERATIVE AI AND AI-ASSISTED TECHNOLOGIES IN THE WRITING PROCESS

During the preparation of this manuscript, generative AI tools such as Grammarly and DeepL were used solely for the purpose of enhancing language clarity, grammar, and structure. All intellectual content, interpretation of results, and final decisions regarding manuscript content were made by the author, ensuring academic integrity and authorship responsibility.

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BIBLIOGRAPHY

1. Santoso D, Rahayu AA, Herawati A, Salsabillah S, Damayanti S, Sulistiyorini D. Kandungan Formalin dan Boraks pada Makanan Jajanan. J Public Heal Educ. 2024;3(3):82–90. https://doi.org/10.53801/jphe.v3i3.186.
2. Sohany M, Syafinaz I, Amin M, Ariffin SH. Characterization of Anthocyanin Associated Purple Sweet Potato Starch and Peel-Based pH Indicator Films. Foods. 2021;10(2005):1–27. https://doi.org/10.3390/foods10092005.
3. Hardianti F, Arman, Gafur A. Identifikasi Kandungan Boraks Pada Bakso Gerobak Di Jl. Paccerakkang Kota Makassar. Wind Public Heal J. 2021;(July):1295–301. https://doi.org/10.33096/woph.v2i5.296.
4. Zilca EZ, Marlik M, Rusmiati R, Nurmayanti D. Assessment of Borax Contamination in Crackers from Jenangan Subdistrict Market : Findings and Recommendations. Int J Adv Heal Sci Technol. 2024;4(3):111–6. https://doi.org/10.35882/ijahst.v4i3.332.
5. Handayani L, Aprilia S, Arahman N, Roil M. Identification of the anthocyanin profile from butterfly pea (Clitoria ternatea L .) flowers under varying extraction conditions : Evaluating its potential as a natural blue food colorant and its application as a colorimetric indicator. South African J Chem Eng [Internet]. 2024;49(February):151–61. Available from: https://doi.org/10.1016/j.sajce.2024.04.008
6. Kuswandi B, Seftyani M. Edible colorimetric label based on immobilized purple sweet potato anthocyanins onto edible film for packaged mushrooms freshness monitoring. J Food Sci Technol. 2024;61(9):1811–22. https://doi.org/10.1007/s13197-024-05960-y.
7. Xia J, Huang J, Zhang H, Zhang N, Li F, Zhou P, et al. Natural flavonols as probes for direct determination of borax : From conventional fluorescence analysis to paper-based smartphone sensing. Talanta [Internet]. 2024;274(January):126053. Available from: https://doi.org/10.1016/j.talanta.2024.126053
8. Nurlailia A, Sulistyorini L, Puspikawati SI. Analisis Kualitatif Kandungan Boraks pada Makanan di Wilayah Kota Banyuwangi. Media Gizi Kesmas. 2021;10(2):254. https://doi.org/10.20473/mgk.v10i2.2021.254-260.
9. Wulandari A, Sunarti T, Fahma F, Noor E. Potency of Purple Sweet Potato ' s Anthocyanin as Biosensor for Detection of Chemicals in Food Products Potency of Purple Sweet Potato ' s Anthocyanin as Biosensor for Detection of Chemicals in Food Products. IOP Conf Ser Earth Environ Sci. 2018;147:1–11. Doi : 10.1088/1755-1315/147/1/012007.

10. Bukhari IM, Kurniawan MF, Hapsari DR. Identifikasi Boraks dan Rhodamin B pada Kerupuk Merah Mentah di Pasar Tradisional Kota Bogor. Karimah Tauhid [Internet]. 2023;2(2):433–41. Available from: https://ojs.unida.ac.id/karimahtauhid/article/view/8106. https://doi.org/10.30997/karimahtauhid.v2i2.8106.
11. Claudia S, Suhada A, Hamdani AS. Analisis Kandungan Boraks Dan Formalin Pada Kerupuk Kulit Sapi Yang Diproduksi Di Wilayah Seganteng Kota Mataram Nusa Tenggara Barat. Pharm Tradit Med. 2022;6(1):8–11. https://doi.org/10.59653/ijmars.v2i02.781.
12. Sulistiyorini D. Qualitative Examination of the Borax and Formalin Content in Food Ingredients and Snack Food. Int J Multidiscip Approach Res Sci. 2024;2(02):954–63. https://doi.org/10.59653/ijmars.v2i02.781.
13. Zhou C, Du J, Zhao H, Xiong Z, Zhao L. Green synthetic carbon quantum dots based on waste tobacco leaves and its application to detecting borax content in flour and its products. J Mol Struct [Internet]. 2023;1278:134959. Available from: https://doi.org/10.1016/j.molstruc.2023.134959
14. Trisdayanti NPE, Prawitha KIT. Analysis of Borax with Butterfly Pea Flower Extract in Puli Crackers. J Gastron Indones. 2022;10(1):1–9. https://doi.org/10.52352/jgi.v10i1.701.
15. Khaodee W, Wongkiti R, Madang S. The Application of Using Natural Reagent Extracted from Purple Sweet Potato for Naked - Eye Detection of Copper in Water Samples. Naresuan Univ J Sci Technol. 2018;26(3):181–8. https://doi.org/10.14456/nujst.2018.9.
16. Rismiarti Z. Optimasi Pelarut Ekstraksi Antosianin Dari Ubi Jalar Ungu (Ipomoea batatas L. Poir) untuk Deteksi Boraks Dalam Makanan. J Atmos. 2022;3(1):8–13.
17. Samanman S, Daengrot C, Hilae A, Ma S, Sayoh I, Masaesai I, et al. A Smart Naked-eye Detection for Fe(III) using Ethanol Extract of Purple Sweet Potato Saluma. Naresuan Univ J Sci Technol. 2023;31(2):1–12. https://doi.org/10.14456/nujst.2023.11.
18. Muhammad R, Hainida E, Ikram K, Sharif MS, Nor N. Current Research in Nutrition and Food Science The Physicochemical Analysis and Anthocyanin Level of Malaysian Purple Sweet Potato Cracker. Curr Res Nutr Food Sci. 2022;10(3):1030–45. https://dx.doi.org/10.12944/CRNFSJ.10.3.19.
19. Salzabilah N, Inayah I, Khaer A. Analysis of Borax Content in Food Using Purple Sweet Potato Extract at Karuwisi Market Makassar. Sulolipu Media Komun Sivitas Akad dan Masy. 2022;22(2):304.
20. Harahap FS, Lubis LT, Pohan HM, Azizah J, Nurmi A. Test of Borax and Formaline on Snacks at Muhammadiyah Elementary Achool Padangsidimpuan City. BioLink J Biol Lingkungan, Ind dan Kesehat. 2022;9(1). Doi : 10.31289/biolink.v9i1.6967.
21. Sumiyani R, Diatmika IKC, Muslimah NH. A low public awareness of illegals red colorants usage : A case study in ketchup and crackers at traditional market of Sukolilo Surabaya A low public awareness of illegals red colorants usage : A case study in ketchup and crackers at traditional market of. IOP Conf Ser Mater Sci Eng. 2020;732:1–6. Doi : 10.1088/1757-899X/732/1/012062.
22. Pratama A, Astuti M, Marsono Y. Identification of Anthocyanidins in Anthocyanin Extract of Purple Sweet Potato (Ipomoea batatas L), Black Rice (Oryza Sativa L), and Black Glutinous Rice (Oryza Sativa V. Glutinosa). J Funct Food Nutraceutical. 2023;5(1):25–32. https://doi.org/10.33555/jffn.v5i1.105.
23. Herawati ERN, Santosa U, Sentana S, Ariani D. Protective Effects of Anthocyanin Extract from Purple Sweet Potato (Ipomoea batatas L.) on Blood MDA Levels, Liver and Renal Activity, and Blood Pressure of Hyperglycemic Rats. Prev Nutr Food Sci. 2020;25(October):375–9. Doi : 10.3746/pnf.2020.25.4.375.
24. Rahmawati E, Prase S, Mahdi C, Srihardyastutie A, Adnyana MO. Potential of Purple Sweet Potato (Ipomoea batatas L) To Increase BDNF Level and VEGF Expression in The Cerebellum of Ischemic Stroke Rats. J Pure Appl Chem Res. 2018;7(January):45–52. https://doi.org/10.21776/ub.jpacr.2018.007.01.363.
25. Putri DP, Yulianti LE, Susanti ND, A Putri SKDF. Detection of borax on snacks for school children (cilok and siomay) in subang district. IOP Conf Ser Earth Environ Sci. 2023;1168(1). Doi : 10.1088/1755-1315/1168/1/012044.
26. Andini AS, Syuhriatin S, Maftuha D. Inventarisasi Bahan Tambahan Makanan (BTM) Penyebab Positif Palsu Pada Uji Kualitatif Boraks Dengan Filtrat Ubi Ungu (Ipomoea batatas L). J Anal Med Biosains. 2020;7(2):87. https://doi.org/10.32807/jambs.v7i2.184.
27. Rismiarti Z, Indra AIN, Agustini SF. Diagnostik Paper Analytical Device (PAD) Menggunakan Ekstrak Ubi Jalar Ungu Untuk Deteksi Boraks Dalam Makanan. Media Penelit dan Pengemb Kesehat. 2024;34(3):697–706. https://doi.org/10.34011/jmp2k.v34i3.1977.

28. Setyawati R, Daryanti I. Identifikasi Boraks Menggunakan Ekstrak Ubi Jalar Ungu. J Syntax Transform. 2020;1(5):162–5. https://doi.org/10.46799/jst.v1i5.75.
29. Safira TM, Yanti R, Triwitono P. Effect of The Ratio of Purple Sweet Potato Flour and Rice Crust Flour on The Physical, Chemical, and Sensory Properties of High-Fiber Snack Bar. J Indones Food Nutr Prog. 2024;21(1):42–50. https://doi.org/10.22146/ifnp.87835.
30. Yun D, Wu Y, Yong H, Tang C, Chen D, Kan J, et al. Recent Advances in Purple Sweet Potato Anthocyanins : Extraction, Isolation, Functional Properties and Applications in Biopolymer-Based Smart Packaging. Foods. 2024;13:1–31. https://doi.org/10.3390/foods13213485.
31. Rusita YD, Hastuti RT. Utilization of Bougainvillea Spectabilis Flower Extract and Red Ashoka Extract as Formaline and Boraxs Teskit. Atl Press. 2023;51:11–9. Doi : 10.2991/978-94-6463-018-3_3.
32. Wardana MBK. Analisis Kadar Boraks pada Kerupuk Puli di Pasar Madiun Menggunakan Metode Kromatografi Lapis Tipis (KLT) dan Spektrofotometri UV-Vis. Skripsi. Fakultas Farmasi. Stikes Bhakti Husada Mulia Madiun. Stikes Bhakti Husada Mulia Madiun; 2021.
33. Milehman A, Napitupulu M. Boraxs and Formalin Analysis in the Shumai Treated in Palu City. J Akad Kim. 2020;9(2):118–24. https://doi.org/10.22487/j24775185.2020.v9.i2.pp118-124.
34. Rahman H, Prajuwita M, Yanni DZ, Sari PM, Lestari I. Analysis of Borax in Ground Red Chilies in the Traditional Markets of Jambi City. EduChemia (Jurnal Kim dan Pendidikan). 2020;5(1):10. http://dx.doi.org/10.30870/educhemia.v5i1.6520.
35. Putri D, Yulianti L, Susanti N, Putri S. Detection of borax on snacks for school children (cilok and siomay) in subang district Detection of borax on snacks for school children (cilok and siomay) in s ubang district. IOP Conf Ser Earth Environ Sci Pap. 2023;1168:1–7. Doi : 10.1088/1755-1315/1168/1/012044.
36. Palimbong S, Sihombing M, Mulyanto MM. The Borax Analysis Of The Crackers At Blauran Market, Salatiga City. J Penelit Pertan Terap. 2024;24(2):276–82. https://doi.org/10.25181/jppt.v24i2.3297.
37. Kossyvaki D, Contardi M, Athanassiou A. Colorimetric Indicators Based on Anthocyanin Polymer Composites : A Review. Polymenrs. 2022;14(19):1–34. https://doi.org/10.3390/polym14194129.