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Improving the Quality and Content of Sweet Potato (*Ipomoea batatas* L.) by Adding Chlorine

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Abstract

Sweet potato (*Ipomoea batatas* L.) is a food commodity with significant potential as an alternative source of carbohydrates. However, damage caused by microbial contamination and quality degradation during storage remains a significant challenge. This study aimed to evaluate the effect of chlorine treatment on sweet potato quality. Chlorine treatment was performed by soaking sweet potatoes in a sodium hypochlorite (NaOCl) solution at a specified concentration for a set duration. Parameters assessed included microbial contamination levels, changes in skin and flesh color, water content, and shelf life. The results demonstrated that chlorine treatment significantly reduced surface microbial populations and slowed the rate of physiological deterioration during storage. Furthermore, chlorination did not adversely affect the physical appearance or organoleptic qualities of the sweet potatoes. Therefore, chlorine treatment can be an effective method for handling sweet potatoes, extending their shelf life and maintaining product quality.

Keywords: Chlorine, Content, Quality, Storage, Sweet Potato

1. Introduction

Sweet potato (*Ipomoea batatas* L.) is a non-rice alternative carbohydrate food source that offers numerous benefits and provides balanced nutrition for maintaining good health (Amagloh et al., 2021).

This tuber crop is cultivated for its nutritional value, starchy roots, and adaptability to a wide range of growing conditions, requiring fewer special inputs and lower management costs compared to potatoes (Solanum tuberosum). Although sweet potato cultivation is widespread worldwide (Carballo et al., 2018; Niu et al., 2019), Asia and Africa account for approximately 85% of global production (El Sheikha and Ray, 2017). Global sweet potato production is reported to reach 105 million metric tons per year (Trancoso et al., 2016). However, the primary challenge in sweet potato cultivation is the decline in tuber quality during storage and distribution due to physiological processes and microbial attacks.

Improper handling can cause physical damage and microbial contamination that accelerates decay. Therefore, effective treatment is needed to reduce the level of damage and extend shelf life. One method that can be applied is washing the tubers with a chlorine solution. Chlorination is a term that refers to the use of chlorine as a disinfectant in the disinfection process through chemical compounds. Some chlorine compounds commonly used as disinfectants include chlorine gas, calcium hypochlorite ($Ca(OCl)2$), sodium hypochlorite (NaOCl), and chlorine dioxide ($ClO2$) (Somani et al., 2011). This method is known as chlorination, which utilizes chlorine as a disinfectant to kill microorganisms. Chlorine, as hypochlorous acid (HOCl) and hypochlorite ion (OCl), is a free or active chlorine compound, which acts as a disinfectant in killing microorganisms. This point is because Hypochlorous acid and hypochlorite ions are toxic to microorganisms. Active chlorine kills microorganisms by damaging the structure of the cell nucleus, which can cause bacteria to lose their permeability (the ability to penetrate), disrupt other cellular functions, and lead to the leakage of proteins, RNA, and DNA, ultimately resulting in bacterial death (Nafisa and Nurhalimah, 2024).

In this context, chlorine has the potential to reduce the number of microbes on the surface of tubers, thereby maintaining product quality and safety during storage. This

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study aims to evaluate the effect of chlorine as a treatment on sweet potatoes. The results are expected to contribute to the development of effective technologies, particularly in extending the shelf life and maintaining the quality of sweet potatoes.

2. Material and Methods

This research will be conducted at the Soil Laboratory or the Soil, Water, and Fertilizer Science Center (SF) Research Malaysian Agricultural Research and Development Institute (MARDI), 43400 Serdang, Selangor, Malaysia. altitude of approximately ± 1347 meters above sea level, coordinate point 6°23'04.3"N 100°14'48.3"E.

The materials used in this study were VitAto variety sweet potatoes, distilled water, a 65% nitric acid solution, and a 37% hydrochloric acid solution. The tools used in the research include an Oven, Grinder Blender, Digital/Analytical Scales, Test Tubes, Test Tube Racks, Fume Hoods, Block Digesters, Glassware Drying, Neoprene Gloves and Rubber Gloves, Volumetric Flask Volume 100ml (Measuring Flask), Paper filters, Stainless Spatulas, Scale paper, stationery, and other supporting equipment.

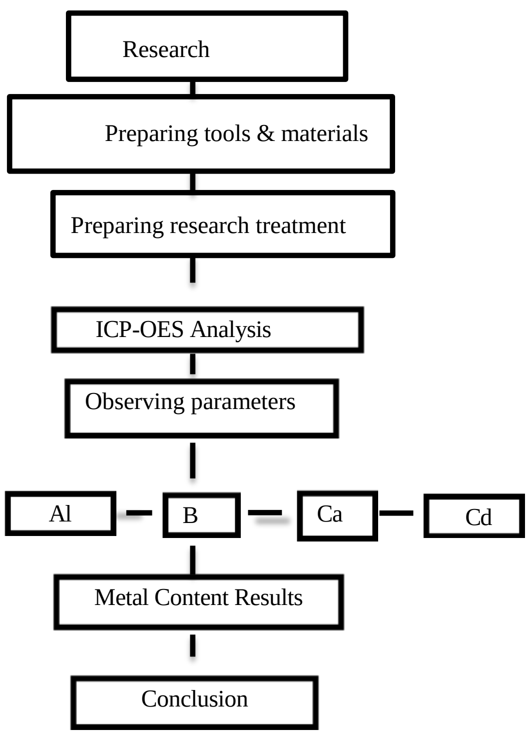

Figure 1. Research Flow Diagram

This study used a completely randomized factorial design method with 2 treatment factors, namely: The first factor is treatment consisting of: T1 = No treatment, T2 = treated, good, washed, not boiled, T3 = treated, good, not washed, boiled, T4 = treated, injured, washed, not boiled, T5 = treated, injured, washed, boiled. The second factor is content, consisting of: M1 = content (flesh from sweet potato), M2 = content (flesh from sweet potato) + skin (skin from sweet potato).

The parameters observed in this study were Aluminum (Al), Boron (B), Calcium (Ca), and Cadmium content. Metal content analysis was conducted using the ICP-OES (Inductively Coupled Plasma Optical Emission Spectrometry) method.

3. Results and Discussion

3.1. Aluminum (Al) content

The results of observations on the Aluminium (Al) content of sweet potatoes treated with chlorine are presented in Table 1.

Table 1. Aluminum content (mg/l)

Treatment	Test			Total	Average
	1	2	3		
T1M1	2.44344	0.29209	0.02243	2.75796	0.919321228
T1M2	0.00315	0.01174	0.02704	0.04192	0.01397321
T2M1	0.00689	0.72880	0.12085	0.85654	0.285512919
T2M2	0.11433	0.06106	0.04117	0.21657	0.072189018
T3M1	0.13964	0.10390	0.08909	0.33263	0.110878059
T3M2	0.03563	0.01640	0.06127	0.11330	0.037766179
T4M1	0.13918	0.09545	0.09848	0.33311	0.111037633
T4M2	0.08770	0.03328	0.09996	0.22094	0.073647116
T5M1	0.13368	0.04460	0.12059	0.29887	0.099624371
T5M2	0.02477	0.02475	0.05028	0.09980	0.033267984

Information: Number, which followed a letter, was the same on line and column, which showed no significant difference in Duncan's Multiple Range Test at the 5% level.

From the analysis of the aluminium content, the average value was obtained. Highest in the treatment without treatment and using sweet potato filling (T1M1) as big as 0.91932, indicating that this treatment had the greatest influence on the observed parameters. On the other hand, the treatment T1M2 shows the lowest average value (0.01397), indicating a significant difference between the M1 and M2 methods in condition T1. Treatment with the M1 and M2 methods, M1 tended to show higher Al levels than M2, especially at levels T1, T2, and T5. At T1, changing the method from M1 to M2 drastically reduced Al levels. At T2 and T4, the decrease from M1 to M2 was also quite significant, although not as drastic as T1. This result indicates that the effectiveness of the method (M) depends on the type of treatment (T). Aluminium toxicity is a significant constraint on global food crop production, originating from stressed soils (Novita et al., 2024). Its toxicity to plants includes inhibition of division, elongation, and root cell elongation, as well as disrupting the structure of the cell cytoskeleton, chloroplasts, and mitochondrial membranes (Novita et al, 2024). Aluminium also interferes with nutrient absorption, transport, and utilization, as well as inhibiting enzyme activity and hormone balance (L. Pincus et al., 2016; W. Wang, 2016).

3.2. Boron (B) Content

The results of observations on the Boron (B) content of sweet potatoes treated with chlorine are presented in Table 2. Based on the results of observations of Boron content, the highest average value was obtained in the T1M1 treatment of 0.1629, while the lowest average value was found in the T1M2 treatment of 0.0254. Generally, treatments with content (M1) tend to have higher average values compared to M2, particularly in groups T1 and T5. However, some groups, such as T3 and T4, showed quite competitive average values between content (M1) and content + skin (M2). These results indicate that each treatment has a different effect on the measured variables, and the T1M1 treatment had the best response in this study.

Table 2. Boron content (mg/l)

Treatment	Test			Total	Average
	1	2	3		
T1M1	0.39813	0.07453	0.01606	0.48871	0.16290231
T1M2	0.01235	0.04104	0.02288	0.07627	0.0254228
T2M1	0.01726	0.05008	0.00993	0.07727	0.02575536
T2M2	0.01457	0.02987	0.01902	0.06346	0.02115268
T3M1	0.02582	0.00337	0.02284	0.05204	0.01734697
T3M2	0.01005	0.06754	0.02614	0.10372	0.03457437
T4M1	0.05333	0.00484	0.01062	0.06878	0.0229282
T4M2	0.03769	0.00996	0.04836	0.09601	0.03200375
T5M1	0.03861	0.01439	0.00750	0.06049	0.02016436
T5M2	0.00696	0.00884	0.02564	0.04144	0.01381254

Information: Number which followed the letter, which was the same on line and column, which showed no significant difference in Duncan's Multiple Range Test at the 5% level.

The study's results showed that boron levels in sweet potatoes varied depending on the combination of treatments applied. The highest boron content was obtained from T1M1, which likely indicates that the T1 treatment (i.e., no washing and peeling) and the M1 method (i.e., minimal treatment) allow more boron to be retained or not lost from the tubers during the process.

3.3. Calcium (Ca) content

The results of observations of Boron (B) content in sweet potatoes treated with chlorine can be seen in Table 3. Based on the table, it can be seen that the combination of treatments T3M2 yields the highest value, with an average of 24.08, while the combination of treatments T1M1 yields the lowest value, with an average of 6.45. The average results show that each main treatment level (T1 to T5) yields different outcomes when combined with content (M1) and content plus skin (M2).

Table 3. Calcium Content (mg/l)

Treatment	Test			Total	Average
	1	2	3		
T1M1	9.75376	4.97498	4.60801	2.75796	0.91932123
T1M2	15,49820	15,33352	15.43430	0.04192	0.01397321
T2M1	5.47155	7,49718	5.24184	0.85654	0.28551292
T2M2	14,60216	17.08094	15,36131	0.21657	0.07218902
T3M1	10.67955	9,29356	9.44182	0.33263	0.11087806
T3M2	22.87931	25,30823	24.04162	0.11330	0.03776618
T4M1	6,80955	10,13912	10.26269	0.33311	0.11103763
T4M2	23,16782	23,05544	20.63225	0.22094	0.07364712
T5M1	6,11717	7.97854	7,20959	0.29887	0.09962437
T5M2	19.85607	16.76929	18,07579	0.09980	0.03326798

Information: Number, which followed a letter, which was the same on line and column, which showed no significant difference in Duncan's Multiple Range Test at the 5% level.

In general, the combination with M2 produces higher values compared to M1. This result indicates that the treatment M2 is more effective in improving overall observation results. The combination of T3M2, T4M2, and T5M2 showed superior results compared to other combinations. This point indicates that not only does one factor play a significant role, but also the interaction between treatment and method determines the outcome. In general, results between replicates were quite consistent, especially for high-value treatments such as T3M2 and T4M2. Slight variations between replicates indicate that the treatments had a stable effect.

From these results, the combination treatment,ofot washed, boiled (T3), and contents (flesh from sweet potato) + skin (skin from sweet potato) (M2) can be recommended as the best treatment for the observed parameters, as it can prodconsistently produceshest values consist This finding can serve as a basis for consideration in wider-scale applications. In contrast, the combination T5M2, which produced the lowest boron content, could be due to treatments that cause boron loss from the tuber tissue, such as intensive washing, peeling, or long-term storage.

In general, it is observed that the difference between methods (M1 and M2) also affects the boron content. At certain treatment levels (e.g., T3 and T4), the M2 method yielded a higher average than M1; however, at T1 and T5, the opposite was true. Sweet potatoes are also a rich source of antioxidants, primarily due to their high polyphenol content (Alam et al., 2016; Wang et al., 2016).

3.4. Cadmium (Cd) content

The results of observations on the boron (B) content in sweet potato treatments with chlorine are presented in Table 4. From the table, it can be seen that the highest average was obtained in the T3M1 treatment, namely 0.000867. The lowest average occurred in the T5M2 treatment, namely 0.000066.

In general, the combination treatment M2 showed a higher average calcium content than M1 at each stage from T1 to T5. This result suggests that the M2 factor (e.g., fertilizer type, cultivation technique, or specific treatment) has a significant impact on the increase in calcium in sweet potatoes.

Table 4. Cadmium content (mg/l)

Treatment	Test			Total	Average
	1	2	3		
T1M1	0.00053	0.00019	0.00001	0.00073	0.00024297
T1M2	0.00005	0.00005	0.00040	0.00050	0.00016762
T2M1	0.00062	0.00049	0.00001	0.00111	0.00037087
T2M2	0.00010	0.00048	0.00043	0.00101	0.00033797
T3M1	0.00240	0.00003	0.00017	0.00260	0.00086679
T3M2	0.00007	0.00030	0.00008	0.00045	0.00014943
T4M1	0.00022	0.00000	0.00030	0.00052	0.00017353
T4M2	0.00007	0.00045	0.00011	0.00064	0.0002117
T5M1	0.00041	0.00023	0.00022	0.00085	0.00028295
T5M2	0.00011	0.00006	0.00003	0.00020	6.6462E-05

Information: The number that followed the letter was the same in both the online and column, showing no significant difference in Duncan's Multiple Range Test at the 5% level.

Based on the data, it can be seen that there are content variations CD, which are quite clear between the various treatment combinations. Treatment T3 (both M1 and M2) showed a tendency for higher Cd values, especially T3M1. This result could indicate that T3 treatment can increase Cd accumulation or be less effective in reducing Cd content.

In the same combination, treatment with M1 tends to produce higher Cd compared to M2, except for T2 and T4, where the values are almost equal. This result suggests that the method or media used (M2) may be more effective in suppressing Cd accumulation compared to M1. The T3M1 combination produces the highest value. This assertion suggests the existence of negative interactions between factors T3 and M1 regarding Cd content. On the contrary, the T5M2 combination is the lowest, which can be considered the best combination in reducing Cd. The results of the second national land survey conducted by the Ministry of Environmental Protection of China showed that 19.4% of agricultural land in China was contaminated, and agricultural land pollution with cadmium (Cd) and lead (Pb) complexes has resulted in substantial economic losses in China (Antoine et al., 2017). Heavy metals are highly toxic and non-biodegradable in soil. Once absorbed by plants, heavy metals can pose health risks to humans through exposure through the food chain (Moreno-Jiménez et al., 2016; Wei et al., 2019).

4. Conclusion

Chlorine administration affects the quality of sweet potatoes, including the content of Aluminium, Boron, Calcium, and Cadmium.

References

Alam, M. K., et al. (2016). Comparison of the proximate composition, total carotenoids, and total polyphenol content of nine orange-fleshed *Ipomoea batatas* varieties grown in Bangladesh. *Foods*.

Amagloh, F. C., Yada, B., Tumuhimbise, G. A., Amagloh, F. K., & Kaaya, A. N. (2021). The potential of sweet potato (*Ipomoea batatas*) as a functional food in Sub-Saharan Africa and its implications for health: A review. *Molecules (Basel, Switzerland)*, 26(10), 2971. https://doi.org/10.3390/molecules26102971

Antoine, J. M. R., et al. (2017). Assessment of the potential health risks associated with the aluminium, arsenic, cadmium, and lead content in selected fruits and vegetables grown in Jamaica. *Toxicology Reports*.

Carballo Pérez, I., Mu, T. H., Zhang, M., & Ji, L. L. (2018). Pengaruh tekanan hidrostatik tinggi pada tepung ubi jalar terhadap sifat dan karakteristik adonan roti gandum-ubi jalar. *International Journal of Food Science and Technology*, 53(4), 1087–1094. https://doi.org/10.1111/ijfs.13687

Pincus, L. (2016). On-farm trial assessing combined organic and mineral fertilizer amendments on vegetable yields in central Uganda. *Agriculture, Ecosystems & Environment*.

Moreno-Jiménez, E., et al. (2016). Availability and transfer to grain of As, Cd, Cu, Ni, Pb, and Zn in a barley agri-system: Impact of biochar, organic, and mineral fertilizers. *Agriculture, Ecosystems & Environment*.

Niu, S., Li, X. Q., Tang, R., Zhang, G., Li, X., Cui, B., & Haroon, M. (2019). Ukuran granula pati dan degradasi pada ubi jalar selama penyimpanan. *Postharvest Biology and Technology*, 150, 137–147. https://doi.org/10.1016/j.postharvbio.2019.01.004

Novita, A., Siregar, L. A. M., Rosmayati, & Rahmawati, N. (2024). Growth and essential oil production of *Vetiveria zizanioides* under salinity conditions with salicylic acid and mycorrhiza application. *Asian Journal of Plant Sciences*, 23(2), 290–303.

Novita, A., Siregar, L. A. M., Rosmayati, & Rahmawati, N. (2024). Growth in the various ecotypes of *Vetiveria zizanioides* at different salinity levels. *E3S Web of Conferences*, 595, 04001.

Trancoso-Reyes, N., Ochoa-Martínez, L. A., Bello-Pérez, L. A., Morales-Castro, J., Estévez-Santiago, R., & Olmedilla-Alonso, B. (2016). Pengaruh pra-perlakuan terhadap sifat fisikokimia dan struktural, serta bioaksesibilitas β-karoten dalam tepung ubi jalar. *Food Chemistry*, 200, 199–205. https://doi.org/10.1016/j.foodchem.2016.01.047

El Sheikha, A. F., & Ray, R. C. (2017). Dampak potensial bioproses ubi jalar: Tinjauan. *Critical Reviews in Food Science and Nutrition*, 57(3), 455–471. https://doi.org/10.1080/10408398.2014.960909

Somani, S. B., Ingole, N. W., & Kulkarni, N. S. (2011). Disinfection of water by using sodium chloride (NaCl) and sodium hypochlorite (NaOCl).

Wang, W. (2019). Amendment with industrial and agricultural wastes reduces surface-water nutrient loss and storage of dissolved greenhouse gases in a subtropical paddy field. *Agriculture, Ecosystems & Environment*.

Wang, S., et al. (2016). Chemical constituents and health effects of sweet potato (*Ipomoea batatas*). *Food Research International*.

Wei, J. X., et al. (2019). Levels of eight heavy metals and health risk assessment considering food consumption by China's residents based on the 5th China total diet study. *Science of the Total Environment*.