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Effect of Curing Period, Plant Hormone and Storage Conditions on the Sensory Quality of Fried Potato (*Solanum tuberosum* L.) Chips

M. Ahmed

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ABSTRACT

Purpose: *In developing countries, 40-50% of horticultural produce is lost yearly due lack of adequate cold chain technology which necessitates the search for a means of storing this produce under ambient conditions with minimal loss to both nutritional and sensory qualities. This study was conducted to assess the effect of the curing period, Abscisic Acids (ABA) levels and storage conditions on the sensory attributes of fried potato chips after 12 weeks of storage*

Research Method: *The experiment was a Split-Split-Plot Design (SSPD) with curing period, storage condition and ABA rates allocated to the main plot, subplot and sub-sub-plot respectively. Treatments were replicated three times; each consisting of 20 potato tubers, and data on sensory properties were taken at the end of the storage period. The data were subjected to Analysis of Variance (ANOVA) using Genstat Discovery Edition. Means that showed significant differences were separated using Duncan's Multiple Range Test (DMRT) at a 0.05% level of probability.*

Findings: *The results showed that curing, storage conditions and ABA rates had a highly significant influence on the organoleptic quality of fried potato chips after storage for 12 weeks under ambient storage conditions. Thus for the best sensory quality of fried potato chips in the study area, tubers should be treated with 4 ppm ABA, cured for seven days, and stored under a shaded pit or heap storage method.*

Research Limitations: *The study evaluated the influence of curing, ABA and storage methods on the sensory attributes of fried potato chips under ambient conditions. The experiment is limited to four curing periods, three ABA rates, three storage conditions and one potato variety (cv Marabel).*

Originality/Value: *This research offers a solution to the distressing problem of huge postharvest loss of potatoes in most developing countries due to a lack of reliable power supply, financial resources and the technical know-how to deploy modern technologies for postharvest management of potato tubers.*

Keywords: *Abscisic acid, color Organoleptic, Potato, Taste, Texture*

INTRODUCTION

Potato (*solanum tuberosum* L) is the third most important food crop in the world after rice and wheat due to its high nutrient content in terms of energy, vitamin C, potassium, protein and dietary fiber (Ayalew *et al.*, 2014; Talei *et al.*, 2017). It is a versatile food that is rich in carbohydrates that contains about 80% water and 20% dry matter, also about 60 to 80% of the dry matter is starch which makes nations that depend on potatoes as a staple food does not suffer from nutritional deficiency (Brar *et al.*, 2017). Potato is also considered as the third major source of phenol after apple and orange (Brar *et al.*, 2017).

Department of Crop Science, Adamawa State University, PMB 25, Mubi | Nigeria.

ahmed361@adsu.edu.ng | ghufran729@yahoo.com

https://orcid.org/0000-0002-5249-8774

The crop is popularly called the ‘king of vegetables because it contains both the wholesomeness and delicacy of cereals, the chemical composition of vegetables (Gumul *et al.*, 2011; Bembem and Sadana, 2013) and sufficient energy (Zaman *et al.*, 2016).It is also an excellent source of high percentage essential amino acids [lysine, leucine, phenyloalanine, threonine and valine], minerals [K, Mg, Fe, Cu, I and P] and vitamins of group B, folic acid, fat-soluble vitamins [E, K, C, and carotenoid a precursor of vitamin A] (Gumul *et al.*, 2011). In addition, it contains phytonutrients or antioxidants that help to inhibit oxidative reactions that produce free radicals or Reactive Oxygen Species (ROS) that are detrimental to health (Burgos *et al.*, 2020).

The Global potato production figures of 378 million tons showed that production is shifting from developed countries to developing ones especially in Asia and Africa (Devaux *et al.*, 2020). Nigeria produces 1.3m tons annually to rank 40th in the world (Factfish.com, 2019; Plaisier *et al.*, 2019).

The short production cycle of potatoes makes it possible to supply food faster than most crops such as cereals or legumes during emergencies and famine. Furthermore, they yield more calories per hectare and require little quantity of water when compared to other crops like wheat or rice (Sonnewald and Sonnewald, 2014). Potato tubers are an excellent staple food due to their high nutritional value, which in addition to their relatively easy cultivation makes potatoes more and more important as a critical crop to feed an increasing world population (Lisinska *et al.*, 2008). According to FAO (2009), potato is a very important part of World food security that could help to alleviate poverty, drive economic development and sustain rural livelihood. The increase in the production of potatoes in the country does not match the level of postharvest management of the produce as observed by Devaux *et al.* (2020) that potato postharvest management is a serious constraint in most developing countries that requires urgent and special attention. Huge postharvest losses occur due to poor harvesting, handling, storage and processing (Teme *et al.*, 2019; Devaux *et al.*, 2020; Jiru and Usmane, 2021). Cold storage is the appropriate method of storing horticultural produce but is not achievable in most developing countries due to insufficient power and, the high cost of equipment, infrastructure, and electricity (Chowdhury, 2018). These make it imperative to devise a means of extending potato dormancy under ambient conditions. Thus, there is a need to find cheap technology to extend potato shelf life under ambient temperatures in the country. Other potato-producing countries facing similar developmental challenges can also benefit from such technology to improve the organoleptic properties of the fried potato chips.

Some studies were conducted on methods of extending potato storage in most developing countries (Khanal and Uprety, 2014; Teme *et al.*, 2019; Jiru and Usmane, 2021). However, the role of the curing period, on-farm storage conditions and ABA rate on the sensory profile of potatoes after the deployment of such technologies in the study area remains unclear. Therefore, it is necessary to investigate the influence and interactions of these factors on the organoleptic attributes of potato tubers after storage under ambient condition which is the main focus of this study.

MATERIALS AND METHODS

Study Area

The research was conducted at the Teaching and Research Farm of Food and Agriculture/ Tree Crop Plantation (FAO/TCP) of Adamawa State University, Mubi ($10°06' - 10°29'N$ and $13°07' - 13°30'E$) with an altitude of 696 m above sea level (Adebayo, 2004; Zemba *et al.*, 2020). It is located within the Northern Guinea Savannah agroecological zones of Nigeria. It has an unimodal rainy season with a mean annual rainfall of 1000 mm. It has a mean maximum temperature of $32.1°C$ and a minimum of $18.5°C$.

Materials and Equipment

Fresh matured dry season potato tubers (Marabel cv) were obtained from Kwaja village in Mubi South Local Government Area of Adamawa State of Nigeria and Abscisic Acid (ABA) with a purity of 95% was purchased from Zhengzhou Panpan Chemical Co. Ltd, China.

Source of Plant Materials

The potato tubers were then allowed to pre-cool under a shade before packing inside a polypropylene bag and transported carefully to the laboratory of Adamawa State University, Mubi for immediate commencement of the research.

Healthy matured dry-season potato tubers free from dirt, mechanical injury, shriveling and rot were selected for the experiment. Selected tubers were immediately cleaned and stored on sharp sand collected from the riverside and covered with black tarpaulin inside the laboratory for curing.

Curing Periods

The potato tubers were subjected to three curing periods (0, 3, 5 and 7 days with 0 day as control) under temperature and relative humidity ($35°C$ and 80% caused by respiration of the tubers due to covering with tarpaulin).

Plant Hormone (Abscisic Acids)

The abscisic acid rates used for the study were 0, 2 and 4 ppm with 0 ppm as the control.

Storage Methods

The storage methods adopted for the research were Heap storage on a concrete floor without any covering (control), Heap Storage between alternate layers of paddy straw and Shaded pit Storage (50 x 50 x 70 cm with alternate layers of paddy straw under shade).

Experimental Design

The experiment was laid out in a Split-Split-Plot Design (SSPD) with a Curing period assigned to the main plot while Storage Condition and ABA levels were allotted to Subplot and Sub-Sub-Plot respectively. Each treatment was replicated three times and the temperature and relative humidity of the storage environment were monitored using a digital Thermo hygrometer throughout the experimental period. Treatment consisted of 20 potato tubers out of which 10 were labeled and earmarked for data collection.

Sampling Techniques and Collection of Data

A random sampling technique was adopted in the selection of the ten representative samples on which data were generated. Data were taken on sensory attributes of fried potato chips at the end of the experiment of 12 weeks.

Sensory analysis)

Sensory analysis was conducted using panelists consisting of youths and adults comprising of males and females within the age range of 15-50 years to assess the effect of the treatments on the sensory properties of the fried potato chips. The potato chips were served to the panelists along with a 9-point hedonic Scale questionnaire for scoring (Appendix 1). The scale scores ranged from 9 (Like Extremely) to 1 (Dislike Extremely) as described by the Society of Sensory Professionals [SSP] (2019). The sensory quality attributes determined were acceptability, aroma, color, taste and texture (Table 1).

Statistical Analysis

Data collected were subjected to Analysis of Variance (ANOVA) using Genstat discovery edition. Means that showed significant differences were separated using Duncan's Multiple Range Test (DMRT) at P = 0.05 level of probability.

RESULTS AND DISCUSSION

Effect of Curing Period on Acceptability of Fried Potato Chips After Storage

There was a highly significant ($P \leq 0.01$) effect of the curing period on the general acceptability of fried potato chips after 12 weeks of storage (Table 01). Fried chips made from potato tubers cured for five days were liked very much by the panelists who gave it the highest score (8.111) of acceptability followed by those cured for zero days (7.667) whereas the lowest score was obtained on both potato tubers cured for seven and three days (7.333) each which was ranked as liked very much while the other curing periods where all ranked equally as liked moderately with a value ranging from 7.333 to 7.667. This could be due to the effect of five days of curing on the nutrient content of the tuber which directly affected its sensory quality. This finding conforms with Jiru and Usmane (2021) who recently reported that six days curing period gave potato products the highest acceptability rating.

Effect of Curing Period on Aroma of Fried Potato Chips after Storage

Table 01 showed that the curing period had a highly significant ($P \leq 0.01$) effect on the aroma of fried potato chips. Chips made from the control sample were ranked as liked moderately with the highest value of (7.667) then followed by the sample cured for three days (6.778) which was regarded as liked slightly. On the other hand, the sample cured for seven days recorded the lowest value (6.222) but was still considered as like slightly by the sensory assessors. The high moisture content of uncured tubers might be the reason for the high aroma caused by the bubbling effect during frying which produces a good aroma. This outcome is in alignment with Saran and Chhabra

Table 1: Effect of Curing Periods, Storage Condition and Abscisic Acid Levels on Organoleptic Properties of Fried Potato after Storage for Twelve Weeks in 2019/2020 Dry Season

Sensory Attributes	Acceptability	Aroma	color	Taste	Texture
Treatments					
CRP days					
0	7.667b	7.667a	7.778a	7.333b	7.444a
3	7.333c	6.778b	7.778a	7.444a	6.222c
5	8.111a	6.556c	7.000b	6.889c	7.000b
7	7.333c	6.222d	6.444c	6.111d	5.778d
P of F	**<0.001**	**<0.001**	**<0.001**	**<0.001**	**<0.001**
S.E (±)	0.0003	0.0002	0.0001	0.0004	0.0002
STC					
Floor	7.333b	6.917a	7.333a	7.083a	6.250c
Heap	7.750a	6.917a	7.250b	6.833c	6.833a
Pit	7.750a	6.583b	7.167c	6.917b	6.750b
P of F	**<0.001**	**<0.001**	**<0.001**	**<0.001**	**<0.001**
S.E (±)	0.0001	0.0003	0.0002	0.0003	0.0001
ABA (ppm)					
0	7.833a	7.083a	7.750a	7.167a	6.833a
2	7.500b	7.000b	7.167b	6.833b	6.667b
4	7.500b	6.333c	6.833c	6.833b	6.333c
P of F	**<0.001**	**<0.001**	**<0.001**	**<0.001**	**<0.001**
S.E (±)	0.0002	0.0004	0.0003	0.0001	0.0003
Interactions					
CRP×STC	**	**	**	**	**
CRP×ABA	**	**	**	**	**
STC×ABA	**	**	**	**	**
CRP×STC×ABA	**	**	**	**	**

Means with the same letter are not significantly different *= Significant, **= Highly Significant, WAS= Weeks After Storage, CRP= Curing Period, STC= Storage Conditions, ABA= Abscisic Acid

(2014) who observed that frying caused a simultaneous mass transfer of heat and moisture resulting in an opposite flow of oil and water (bubbles) that lead to the release of desirable aroma in potato products.

Effect of Curing Periods on the Color of Fried Potato Chips After Storage

Curing periods influenced the color of potato chips in a highly significant ($P \leq 0.01$) way after 12 weeks of storage (Table 01). Potato tubers cured for zero and three days both recorded the topmost ranking of liked moderately (7.778) followed by chips from potatoes cured for five days with a value of 7.00 which was also termed as liked moderately by sensory analysts. On the contrary, chips from potatoes cured for seven days had the lowest ranking of 6.444 and were valued by sensory analysts as liked slightly. This could be attributable to both enzymatic and non-enzymatic chemical discoloration instigated by respiration burst during long curing which led to changes in reducing sugar. This result is in agreement with Lisinska *et al.* (2009) and Saran and Chhabra (2014) who stated that a brief respiration burst followed by a subsequent decrease in respiration rate to a steady state during long-term storage leads to the conversion of sucrose to reducing sugar.

Effect of Curing Periods on Taste of Fried Potato Chips after Storage

Curing treatment of potato tubers before storage affected the taste of fried potato chips in a highly significant ($P \leq 0.01$) way as depicted in Table 01. The highest valuation of 7.444 was gained on chips from potatoes cured for three days while those treated with zero days of curing attained the second valuation of 7.333 after the 12 weeks of storage and both were judged liked moderately by the panel of sensory judges. On the other side, potato tubers cured for seven days produced chips that received the lowest valuation with 6.111 and were deemed liked slightly by the judges. The highest valuation that was gained on chips from potatoes cured for three days partly because of the short curing period that did not allow for acrylamide formation and glycoalkaloids that affect the fried chips' taste. This result is in line with Yee and Bussell (2007); Jansky (2010); and Jiru and Usmane (2021) who explained that the taste of fried potato is affected by non-enzymatic browning related to acrylamide formation associated with conditioning period, storage method and temperature.

Effect of Curing Periods on Texture of Fried Potato Chips after Storage

There was a highly significant ($P \leq 0.01$) difference between cured and uncured chips in terms of the textural properties of fried potato chips stored for 12 weeks as presented in Table 01. Fried chips prepared from potato tubers cured for zero days were counted as liked moderately by the sensory panelists who awarded the highest score (7.444), followed by those cured for five days (7.000) and were also adjudged as like moderately. However, the lowest score was recorded on chips from potato tubers cured for seven days (5.778) which was declared as neither like nor dislike. This could be attributed to a high moisture/dry matter content ratio due to non-curing. This is in line with Lisinskas *et al.* (2009); and Jansky's (2010) findings are contrary to Jiru and Usmane (2021) found dissimilar results and showed that potatoes lose water during storage and become less turgid leading to cell elasticity thereby causing mealy texture.

Effect of Storage Conditions on Acceptability of Fried Potato Chips after Storage

There was a highly ($P \leq 0.01$) significant impact of storage conditions on the general acceptability of fried potato chips after 12 weeks of storage as displayed in Table 01. Fried chips made from potato tubers stored in a heap and shaded pit storage were both equally graded as moderate by sensory evaluators and allocated the highest value of acceptability (7.750 each) while the lowest value of 7.333 was gotten from fried chips processed from potato tubers stored on the floor and still declared as liked moderately. This could be accredited to the storage conditions that affect quality properties that relate to sensory attributes of processed potato tubers such as acceptability. This outcome is in line with Lisinska *et al.* (2009); Jansky (2010): and Saran and Chhabra (2014) who stated that storage condition affects both nutritional and sensory qualities, especially its acceptability.

Effect of Storage Conditions on Aroma of Fried Potato Chips after Storage

Storage condition had a highly ($P \leq 0.001$) significant effect on the aroma of fried potato chips processed from tubers cured under various storage conditions as presented in Table 01. Samples stored on the floor and in the heap were rated as liked slightly with the highest value of (6.917) each. On the other hand, the samples stored in shaded pit storage posted the lowest aroma ranking (6.583) nonetheless still classified as liked slightly during sensory assessment. It could be caused by the role of storage conditions in reducing respiration that helps in preserving the nutrient composition of the tuber which directly affects its sensory attributes. These findings are in line with Jansky (2010) who reported that storage conditions affect the sensory quality of cooked potatoes.

Effect of Storage Conditions on the color of Fried Potato Chips after Storage

Table 01 indicated that there was a highly significant ($P \leq 0.001$) difference between treated and untreated samples in terms of the color of fried potato chips after 12 weeks in storage due to different storage conditions. Fried chips obtained from potato tubers stored on the floor recorded the highest ranking (7.333) followed by chips from potatoes stored in a heap (7.250) while the lowest ranked (7.167) chips were from potatoes stored in shaded pit. Despite the difference in ranking, they were all assessed equally as liked moderately by sensory analysts. This could be attributable to the effect of storage conditions on nutrient content which influenced the final color. It is also consistent with Yee and Bussell (2007); Lisinska *et al.* (2009); Jiru and Usmane (2021) who revealed that storage conditions affected sensory attributes of potato tubers in storage.

Effect of Storage Conditions on Taste of Fried Potato Chips after Storage

Subjecting potato tubers to different storage conditions affected the taste of fried potato chips in a highly significant ($P \leq 0.001$) manner as illustrated in Table 01. The highest grade of 7.083 was achieved on chips from potatoes stored on the floor and regarded as liked moderately whilst those subjected to shaded pit storage managed the second grade of 6.917 and were considered liked slightly according to sensory evaluators. On the contrary, potato tubers stored in heap produced chips that had the minimum grade of 6.833 and were viewed also as like slightly. The difference could be attributed to the effect of storage conditions on the proximate composition of potatoes which affected the taste (Yee and Bussell, 2007; Jansky, 2010; Saran and Chhabra, 2014).

Effect of Storage Condition on Texture of Fried Potato Chips after Storage

There was a highly ($P \leq 0.001$) significant effect of storage conditions on the texture of fried potato chips after 12 weeks of storage as demonstrated in Table 01. Fried chips from potato tubers stored in a heap were regarded as liked slightly by the sensory panelists who gave it the highest mark (6.833), followed by those stored in the shaded pit (6.667) but all were valued as liked slightly. Even though the lowest mark was realized on chips from potato tubers stored on the floor (6.250) it was still announced as liked slightly. The result may be credited to the effect of storage conditions on the nutrient content of the potato tubers which in turn affected its texture. This is similar to Yee and Bussell (2007); Jansky (2010); Saran and Chhabra (2014); and Jiru and Usmane (2021) who observed that storage conditions affect the texture of potato chips.

Effect of ABA Level on Acceptability of Fried Potato Chips after Storage

There was a highly ($P \leq 0.001$) significant impact of ABA levels on the acceptability of fried potato chips after 12 weeks of storage as presented in Table 01. Fried chips made from potato tubers having 0 ppm dose of ABA were marked as liked moderately by sensory assessors because of their greatest acceptability ranking (7.833). However, the lowest ranking of 7.500 each was recorded from fried chips processed from both potato tubers dosed with 2 and 4 ppm ABA levels which were acknowledged also as liked moderately. This could be ascribed to the role of ABA on the nutritional quality that subsequently influences the acceptability of potato chips. This outcome was supported by Saran and Chhabra (2014) who reported that plant hormones like ABA have an indirect effect on the sensory attributes of potato chips through their effect on the nutrient content.

Effect of ABA Levels on Aroma of Fried Potato Chips after Storage

The application of different rates of ABA had a highly ($P \leq 0.001$) significant effect on the aroma of fried potato chips processed from it as proven by Table 01. The application of 0 ppm of ABA on potato tubers caused the aroma of the fried chips to be liked moderately by sensory panelists because of its highest aroma rating (7.083) each. It was straggled by tubers that received 2 ppm application of ABA with a rating of 7.000 which was also liked moderately. The lowest aroma rating (6.333) was found on tubers that had 4 ppm ABA application and labeled as like slightly. This outcome could be linked to the effect of ABA on the respiration of the tuber. This outcome was reaffirmed by Saran and Chhabra (2014) who related that plant hormones affect the processing quality (nutritional and sensory) of fried potato chips.

Effect of ABA Levels on the color of Fried Potato Chips after Storage

Table 01 portrayed that there was a highly significant ($P \leq 0.001$) variation between treated and untreated potato samples in terms of the color of fried potato chips after 12 weeks in storage due to varying ABA rates. Fried chips obtained from potato tubers misted with 0 ppm ABA posted the highest rate (7.750) trailed by chips obtained from potatoes misted with 2 ppm ABA (7.167) and both were termed as liked moderately by sensory judges. The lowest-rated chips were from potatoes misted with 4 ppm ABA (6.833) and were valued as liked slightly. This could be due to the effect of ABA on the dormancy extension. The finding was similar to Lisinskas *et al.* (2009); and Jansky (2010) who related that sugar, lipid, and RNA reactions that cause Mailard browning processing of fried potato chips affect the color.

Effect of ABA Levels on Taste of Fried Potato Chips after Storage

Variation in ABA levels on potato tubers after 12 weeks in storage had influenced the taste of fried potato chips in a very highly significant ($P \leq 0.001$) style as elucidated in Table 01. The greatest rank of 7.167 was obtained on chips from potatoes subjected to a treatment of 0 ppm ABA and regarded as liked moderately. Whereas those subjected to 4 ppm ABA gave the least ranked chips (6.833 each) and were considered as liked slightly by sensory evaluators. This could be ascribed to the effect of ABA which promotes starch degradation and these findings agreed with Chen *et al.* (2020); Hsu *et al.* (2021) who both reported that ABA helps in degrading the starch content in potato tubers.

Effect of ABA Levels on Texture of Fried Potato Chips after Storage

Abscisic acid levels had a highly ($P \leq 0.001$) significant impact on the texture of fried potato chips after 12 weeks of storage as exhibited in Table 01. Fried chips made from potato tubers treated with 0 ppm of ABA gave the highest points (6.833), tailed by those treated with 2 ppm ABA (6.667) and the lowest point was deduced on chips from potato tubers treated with 4 ppm (6.333). Nonetheless, all were categorized as liked slightly by the sensory assessors. This finding may be due to the role of ABA in retarding respiration which minimizes both dehydration and nutrient depletion in treated samples while depleting both moisture and nutrient content in untreated samples which in turn influences processed texture. This result is in tandem with Lisinskas *et al.* (2009) who observed that a low respiration rate influences the texture of fried potato chips.

Interaction between Curing Periods and Storage Conditions on Acceptability of Fried Potato Chips after Twelve Weeks of Storage

Table 02 presented the interactive effect between curing periods and storage conditions on the acceptability of fried potato chips after storage. There was a very highly significant ($P \leq 0.001$) interaction between the two factors under consideration. Potatoes cured for five days and stored on the floor produced the highest acceptability (8.00) rating and were considered liked very much by the panel of sensory judges, those cured for zero days gave the lowest acceptability (6.33) rating and thought to be liked slightly by them. Altering storage conditions from floor to heap caused samples cured for zero days to give the highest value (8.33) which is regarded as like very much whereas those cured for three and seven days had the lowest value (7.33 each) and were placed as like moderately. A further modification of storage condition to the shaded pit method encouraged both samples cured for zero and five days to produce the leading value (8.33) and rated as like very much but samples cured for seven days supplied the lowest value (7.00) and rated as like moderately.

These variations could be due to the joint Effect of curing periods and storage conditions on the chip's acceptability. This outcome corroborated the findings of Lisinska *et al.* (2009); and Saran and Chhabra (2014) who stated that curing periods and storage conditions affect both nutritional and sensory quality.

Interaction between Curing Periods and Storage Conditions on Aroma of Fried Potato Chips after Twelve Weeks of Storage

Table 03 shows the interactive effect between curing periods and storage conditions on the aroma of fried potato chips after 12 weeks of storage. There was a highly significant ($P \leq 0.001$) interaction between them. Fried potato chips processed from potato tubers cured for zero days and stored on the floor produced the highest (7.33) aroma ranking and were scored as like moderately by sensory assessors. Potato fried chips from tubers cured for three and five days gave the lowest (6.67) aroma ranking and was termed liked slightly. Changing storage conditions from floor to heap caused samples cured for zero days to again give the highest (8.00) aroma value which was labeled as liked very much whereas those cured for five days produced the fried potato chips with the lowest (6.00) aroma value and rated liked slightly. Moreover, the alteration of storage condition to the shaded pit method encouraged samples cured for zero days to continue producing the most preferred chips (7.67) in terms of aroma but samples cured for seven days supplied the least preferred fried chips (5.33) and were called either liked nor disliked. This outcome could be a result of the combined impact of the curing period and storage condition which is also in consonance with Saran and Chhabra (2014) who related that curing and storage environment influence the sensory attributes of processed potato chips.

Interaction between Curing Periods and Storage Conditions on color of Fried Potato Chips after Twelve Weeks of Storage

In Table 04, the interaction between curing periods and storage conditions on the color of fried potato chips processed from tubers kept for 12 weeks was highly significant ($P \leq 0.001$). Potato fried chips made from tubers cured for three and five days and stored on the floor produced the chips with the highest color preference (7.67 each) during sensory analysis and characterized as liked moderately whilst those from tubers cured for zero and seven days borne chips with the lowest (7.00) color preference and branded also as liked moderately. Modifying the storage condition to heap method triggered samples from tubers cured for three days to give fried chips with the highest (8.33) color preference that was described as liked very much but those from tubers cured for five and seven days produced chips with the lowest (6.33) color preference which was categorized as liked slightly. In addition, switching storage conditions to the shaded pit method made samples cured for zero days to still generate chips with the highest (8.33) color preference which are regarded as very much while samples from tubers cured for seven days yielded chips with the lowest (6.00) color preference perceived as also liked slightly. The result of this study is congruent with that of Yee and Bussell (2007); Lisinska *et al.* (2009); and Jiru and Usmane (2021) who stated that curing and storage

Table 2: Interaction between Curing Periods and Storage Conditions on Acceptability of Fried Potato Chips after 12 Weeks of Storage

Storage Condition	Floor	Heap	Pit
Curing Periods (Days)			
0	6.33	8.33	8.33
3	7.33	7.33	7.33
5	8.00	8.00	8.33
7	7.67	7.33	7.00
S.E (±)		<0.0001	

Table 3: Interaction between Curing Periods and Storage Conditions on Aroma of Fried Potato Chips after 12 Weeks of Storage

Storage Condition	Floor	Heap	Pit
Curing Periods (Days)			
0	7.33	8.00	7.67
3	6.67	7.33	6.33
5	6.67	6.00	7.00
7	7.00	6.33	5.33
S.E (±)		<0.0001	

Table 4: Interaction between Curing Periods and Storage Conditions on color of Fried Potato Chips after 12 Weeks of Storage

Storage Condition	Floor	Heap	Pit
Curing Periods (Days)			
0	7.00	8.00	8.33
3	7.67	8.33	7.33
5	7.67	6.33	7.00
7	7.00	6.33	6.00
S.E (±)		0.0001	

methods affect the color of fried potato chips.

Interaction between Curing Periods and Storage Conditions on Taste of Fried Potato Chips after Twelve Weeks of Storage

The interaction between curing periods and storage conditions on the taste of fried potato chips obtained from tubers stored for 12 weeks had a highly significant ($P \leq 0.001$) effect as presented in Table 05. Chips from potato tubers cured for three days and stored on the floor received the highest taste score (8.00) from the sensory evaluators who viewed it as liked very much meanwhile, those from tubers cured for zero and seven days had the lowest (6.67) score which was considered as liked slightly. Changing storage conditions from floor to heap caused chips from tubers cured for zero and three days to give the highest taste fondness of 7.33 each and seen as moderate whereas tubers cured for five days produced chips that attracted the lowest (6.00) taste fondness but still graded as liked slightly. In furtherance, substituting storage condition to the shaded pit method made samples from tubers cured for zero days continue commanding the highest (8.00) taste fondness with the rank of liked very much but samples from tubers cured for seven days were awarded the lowest (5.67) taste rank of neither like nor dislike. The collaborative effect of curing and storage conditions might be responsible for this development and a similar opinion was espoused by other researchers (Yee and Bussell, 2007; Jansky, 2010; Saran and Chhabra, 2014).

Interaction between Curing Periods and Storage Conditions on Texture of Fried Potato Chips after Twelve Weeks of Storage

There was a highly significant ($P \leq 0.001$) interaction between curing periods and storage conditions on the texture of potato fried chips as shown in Table 06. Potato cured for five days and stored on the floor produced chips with the highest (7.00) textural rating and appraised as liked moderately by the sensory analysts. Those cured for three gave the lowest (5.67) textural rating and were assessed as neither liked nor

Table 5: Interaction between Curing Periods and Storage Conditions on Taste of Fried Potato Chips after 12 Weeks of Storage

Storage Condition	Floor	Heap	Pit
Curing Periods (Days)			
0	6.67	7.33	8.00
3	8.00	7.33	7.00
5	7.00	6.67	7.00
7	6.67	6.00	5.67
S.E (±)		0.0004	

Table 6: Interaction between Curing Periods and Storage Conditions on Texture of Fried Potato Chips after 12 Weeks of Storage

Storage Condition	Floor	Heap	Pit
Curing Periods (Days)			
0	6.33	8.00	8.00
3	5.67	6.67	6.33
5	7.00	7.33	6.67
7	6.00	5.33	6.00
S.E (±)		0.0003	

Table 7: Interaction between Curing Periods and Abscisic Acids Levels on Acceptability of Fried Potato Chips at 12 Weeks after Storage

Abscisic Acids Levels (ppm)	0	2	4
Curing Periods (Days)			
0	8.33	7.67	7.00
3	7.33	7.00	7.67
5	7.67	8.33	8.33
7	8.00	7.00	7.00
S.E (±)		0.0002	

disliked. Replacing floor storage condition with heap caused samples cured for zero days to give the highest (8.00) value in terms of chips texture which was judged as liked very much whereas those cured for seven days had chips with the lowest (5.33) textural grading of neither liked nor disliked.

Similarly, the substitution of heap storage condition with the shaded pit method caused chips made from the samples cured for zero days to continue producing chips with the highest (8.00) texture that was evaluated as liked very much also on the other hand samples cured for seven days again supplied the chips with the lowest (6.00) textural value and gauged as liked slightly by the analysts. This could be caused by the cumulative action of these factors under study on the texture of chips which is similar to the opinions of Saran and Chhabra (2014); and Jiru and Usmane (2021) who upheld that curing and storage conditions influence the sensory attribute of fried potato chips.

Interaction between Curing Periods and ABA Levels on Acceptability of Fried Potato Chips after Twelve Weeks of Storage

There was a significantly high ($P \leq 0.001$) interaction between curing periods and ABA levels throughout the experimental period (Table 07). At 0 ppm ABA tubers cured for zero days produced fried chips with the greatest acceptability value (8.33) that was considered as very much by a panel of sensory assessors whilst the lowest value (7.33) was reported on chips from tubers cured for three days. Nonetheless, chips from potato tubers treated with 2 ppm ABA and cured for five days had the greatest value of acceptability (8.33) and valued as like very much whereas the least acceptability value (7.00) was found on tubers cured for three and seven days which was measured as like moderately. Then when the ABA level was further concentrated to 4 ppm, chips from tubers cured for five days still generated the greatest value of acceptability (8.33) which was rated as very much. While least acceptability (7.00 each) was also recorded on chips from tubers cured for zero and seven days but were graded as moderate.

Table 8: Interaction between Curing Periods and Abscisic Acids Levels on Aroma of Fried Potato Chips at 12 Weeks after Storage

Abscisic Acids Levels (ppm)	0	2	4
Curing Periods (Days)			
0	8.33	8.00	6.78
3	7.33	6.33	6.67
5	6.67	7.00	6.00
7	6.00	6.67	6.00
S.E (±)		0.0001	

Table 9: Interaction between Curing Periods and Abscisic Acids Levels on color of Fried Potato Chips at 12 Weeks after Storage

Abscisic Acids Levels (ppm)	0	2	4
Curing Periods (Days)			
0	8.67	7.67	7.00
3	8.33	7.67	7.33
5	7.33	7.67	6.00
7	7.67	5.67	7.00
S.E (±)		0.0001	

Table 10: Interaction between Curing Periods and Abscisic Acids Levels on Taste of Fried Potato Chips at 12 Weeks after Storage

Abscisic Acids Levels (ppm)	0	2	4
Curing Periods (Days)			
0	7.33	7.33	7.33
3	7.67	7.00	7.67
5	7.00	7.33	6.33
7	6.67	5.67	6.00
S.E (±)		0.0002	

Table 11: Interaction between Curing Periods and Abscisic Acids Levels on Texture of Fried Potato Chips at 12 Weeks after Storage

Abscisic Acids Levels (ppm)	0	2	4
Curing Periods (Days)			
0	8.00	7.67	6.67
3	6.67	6.00	6.00
5	6.67	7.33	7.00
7	6.00	5.67	5.67
S.E (±)		0.0002	

Table 12: Interaction between Storage Conditions and Abscisic Acid Levels on Acceptability of Fried Potato Chips at 12 Weeks after Storage

ABA Levels (ppm)	0	2	4
Storage Condition			
Floor	7.50	7.25	7.25
Heap	8.00	7.50	7.75
Pit	8.00	7.75	7.50
S.E (±)		0.0003	

The significantly very high interaction observed between curing periods and ABA levels throughout the experimental period could be due to the combined effect of the two factors on the acceptability of fried chips. This view was validated by Saran and Chhabra (2014) and Jiru and Usmane (2021) who reported that curing and plant growth regulators have some bearing on the general acceptability of fried potato chips.

Interaction between Curing Periods and ABA Levels on Aroma of Fried Potato Chips after Twelve Weeks of Storage

Curing periods and ABA levels interacted in a highly significant ($P \leq 0.001$) pattern on fried potato chips throughout the experimental period as shown in Table 08. An application of 0 ppm ABA to potato tubers and cured for zero days produced potato chips that had the highest aroma grading of 8.33 and were regarded as liked very much whilst those cured for seven days had the lowest aroma grading of 6.00, regarded as like slight by sensory panelists. Equally, dosing potato tubers with 2 ppm ABA and cured for zero days when processed into chips still gave the greatest aroma value of 8.00 which was valued as liked very much whereas the lowest aroma value of 6.33 was found on chips from tubers cured for three days and valued at liked slightly. In furtherance to that, an increment in ABA level to 4 ppm affected the chips tubers cured for zero days to continue generating the product with the greatest aroma value of 6.78 though the least value of 6.00 each were obtained on products from tubers cured for five and seven days nevertheless, both the greatest and least values were evaluated as liked slightly by the panelists.

The high significance expressed on the aroma of fried potato chips throughout the experimental period by the two factors could be instigated by the paired influence of curing periods and ABA levels as earlier verified by Saran and Chhabra (2014) who reported that curing period and plant hormones affect chips' sensory attributes.

Interaction between Curing Periods and ABA Levels on color of Fried Potato Chips after Twelve Weeks of Storage

The interaction effect between curing periods and ABA levels was significantly high ($P \leq 0.001$) during the twelve studies as demonstrated in Table 09. Potato tubers misted with 0 ppm ABA and cured for zero days produced fried chips with the best color (8.67) and ranked as liked very much although the poorest color value (7.33) was found on fried chips from tubers cured for five days which ranked as liked moderately by the sensory judges. As potato tubers were further misted with 2 ppm ABA, tubers cured for zero, three, and five days had the best chip color (7.67each) which were all rated as liked moderately whereas the poorest color value (5.67) was found on chips from tubers cured for seven days and rated as neither liked nor disliked. A further increase in ABA level to 4 ppm, tubers cured for three days created potato fried chips with the best color value (7.33) that was rated as liked moderately. However, the poorest value (6.00) was observed on fried chips tubers cured for five days which was rated as liked slightly.

The highly significant interaction effect could be attributed to the double impact of the curing period and ABA rates on color. This outcome agreed with Saran and Chhabra (2014); and Jiru and Usmane (2021) who reported that curing and sprout inhibitors can influence the color of fried potato chips.

Interaction between Curing Periods and ABA Levels on Taste of Fried Potato Chips after Twelve Weeks of Storage

Table 10 presented the interactive effect of curing periods and ABA levels on the taste of fried potato chips during twelve weeks of storage. There was a highly significant ($P \leq 0.001$) interface between curing periods and ABA levels; at 0 ppm ABA treatment, tubers cured for three days were processed into fried chips with the greatest taste value of 7.67 even though, the least taste value of 6.67 was reported on fried chips processed from tubers cured for seven days and were graded as liked moderately and liked slightly respectively by sensory evaluators.

Treating potato tubers with 2 ppm ABA, made both tubers cured for zero and five days to produce chips with equal greatest taste (7.33 each) whereas the lowest taste value (5.67) was gotten from tubers cured for seven days which were graded as liked moderately and neither liked nor disliked respectively. An additional increment of ABA level to 4 ppm, made chips with the greatest taste value (7.67) to emanate from tubers cured for three days and was considered liked moderately. Despite that, tubers cured for seven days again produced fried potato chips with the least (6.00) taste value which is considered liked slightly.

The interactive effect of curing periods and ABA levels on the taste of fried potato chips during 12 weeks of storage had a highly significant interface as 0 ppm ABA-treated tubers cured for three days

Table 13: Interaction between Storage Conditions and Abscisic Acid Levels on Aroma of Fried Potato Chips at 12 Weeks after Storage

ABA Levels (ppm) Storage Condition	0	2	4
Floor	7.75	7.00	6.50
Heap	7.00	7.00	7.00
Pit	6.00	6.75	6.25
S.E (±)		0.0003	

Table 14: Interaction between Storage Conditions and Abscisic Acid Levels on color of Fried Potato Chips at 12 Weeks after Storage

ABA Levels (ppm) Storage Condition	0	2	4
Floor	7.75	8.00	7.50
Heap	7.25	7.25	7.00
Pit	7.00	6.50	7.00
S.E (±)		0.0002	

Table 15: Interaction between Storage Conditions and Abscisic Acid Levels on Taste of Fried Potato Chips at 12 Weeks after Storage

ABA Levels (ppm) Storage Condition	0	2	4
Floor	7.25	7.25	7.00
Heap	7.50	6.25	6.75
Pit	6.50	7.00	7.00
S.E (±)		0.0001	

were processed into fried chips with the greatest taste value that was graded as liked moderately by sensory evaluators. Treating potato tubers with 2 ppm ABA, made tubers cured for zero and five days to give fried chips with the greatest taste which was graded as liked moderately. An additional increment of ABA level to 4 ppm, made chips with the greatest taste value to emanate from tubers cured for three days and was considered liked moderately.

This impact could be due to the coupled effect of the two factors which was also akin to the findings of Saran and Chhabra (2014); Jiru and Usmane (2021) who observed that curing and plant hormones have affected the taste of fried potato chips.

Interaction between Curing Periods and ABA Levels on Texture of Fried Potato Chips after Twelve Weeks of Storage

There was a significantly high ($P \leq 0.001$) interaction between curing periods and ABA levels throughout the experimental period as depicted in Table 11. At 0ppm ABA tubers cured for zero days produced the greatest value for fried potato chips (8.00) in terms of texture whilst least potato chips texture value (6.00) was reported on tubers cured for seven days and evaluated as like very much and liked slightly accordingly from sensory evaluators' point of view.

Likewise, after dosing the samples with 2 ppm ABA, fried chips from tubers cured for zero days textured highly (7.67) and regarded as liked moderately whereas fried chips from tubers cured for seven days textured poorly (5.67) and regarded as neither liked nor disliked. Doubling of ABA level to 4 ppm, caused tubers cured for five days to produce fried chips with the highest texture value (7.00). While least value (5.67) continuously originated from chips of potato cured for seven days similar to those in the previous case and both were classified as the previous classification (liked moderately and neither liked nor disliked appropriately). This outcome could be attributed to the twin effect of the curing period and ABA level on

Table 16: Interaction between Storage Conditions and Abscisic Acid Levels on Texture of Fried Potato Chips at 12 Weeks after Storage

ABA Levels (ppm) Storage Condition	0	2	4
Floor	6.75	6.25	6.25
Heap	7.25	6.25	6.25
Pit	6.25	6.25	6.25
S.E (±)		0.0001	

Table 17: Interaction between Curing Periods, Storage Conditions, and Abscisic Acid levels on Acceptability of Fried Potato Chips at 12 Weeks after Storage

Curing Periods (Days)	Storage Conditions	Abscisic Acids Levels (ppm)		
		0	2	4
0	Floor	7	7	5
	Heap	9	8	8
	Pit	9	8	8
3	Floor	8	6	8
	Heap	7	7	8
	Pit	7	8	7
5	Floor	7	9	8
	Heap	8	8	8
	Pit	8	8	9
7	Floor	8	7	8
	Heap	8	7	7
	Pit	8	7	6
S.E (±)		0.0002		

Table 18: Interaction between Curing Periods, Storage Conditions and Abscisic Acid levels on the Aroma of Fried Potato Chips at 12 Weeks after Storage

Curing Periods (Days)	Storage Conditions	Abscisic Acids Levels (ppm)		
		0	2	4
0	Floor	9	8	5
	Heap	8	8	8
	Pit	8	8	7
3	Floor	7	6	7
	Heap	7	7	8
	Pit	8	7	7
5	Floor	8	7	5
	Heap	5	6	6
	Pit	7	7	7
7	Floor	7	7	7
	Heap	7	6	6
	Pit	4	7	5
S.E (±)		0.0002		

Table 19: Interaction between Curing Periods, Storage Conditions and Abscisic Acid Levels on the color of Fried Potato Chips at 12 Weeks after Storage

Curing Periods (Days)	Storage Conditions	Abscisic Acids Levels (ppm)		
		0	2	4
0	Floor	8	8	5
	Heap	9	7	8
	Pit	9	8	8
3	Floor	8	7	8
	Heap	9	8	8
	Pit	8	8	6
5	Floor	8	8	7
	Heap	7	8	4
	Pit	7	7	7
7	Floor	7	6	8
	Heap	7	6	6
	Pit	6	5	7
S.E (±)		0.0003		

Table 20: Interaction between Curing Periods, Storage Conditions and Abscisic Acid Levels on Taste of Fried Potato Chips at 12 Weeks After Storage

Curing Periods (Days)	Storage Conditions	Abscisic Acids Levels (ppm)		
		0	2	4
0	Floor	7	7	6
	Heap	7	7	8
	Pit	8	8	8
3	Floor	8	8	8
	Heap	8	6	8
	Pit	7	7	7
5	Floor	8	8	7
	Heap	7	8	4
	Pit	7	7	7
7	Floor	7	7	6
	Heap	7	5	6
	Pit	5	6	5
S.E (±)		0.0003		

the texture of the chips as earlier postulated by Jiru and Usmane (2021) who positioned that curing and plant growth regulators influence the texture of fried potato chips.

Interaction between Storage Conditions and ABA Levels on Acceptability of Fried Potato Chips after Twelve Weeks of Storage

The interaction effect of storage conditions and ABA rates during 12 weeks of storage on the acceptability of potato fried chips is presented in Table 12, a highly significant ($P \leq 0.001$) interaction was noticed throughout the study period. The application of 0 ppm of ABA caused samples stored on heap and pit to produce the most accepted (8.00 each) fried potato chips which were considered liked very much that notwithstanding, fried chips from tubers stored on the floor had the least (7.50) accepted chips and considered as liked moderately by a panel of sensory assessors. When ABA was topped up to 2 ppm, the chips from samples stored in the shaded pit were accepted highly (7.75) even though chips from tubers stored on were least (7.25) accepted by the panel of assessors but both were categorized as moderately. When ABA was again topped up to 4 ppm provoked chips from potatoes

Table 21: Interaction between Curing Periods, Storage Conditions and Abscisic Acid Levels on Texture of Fried Potato Chips at 12 Weeks after Storage

Curing Periods (Days)	Storage Conditions	Abscisic Acids Levels (ppm)		
		0	2	4
0	Floor	7	7	5
	Heap	8	8	8
	Pit	9	8	7
3	Floor	7	5	5
	Heap	7	6	7
	Pit	6	7	6
5	Floor	7	7	7
	Heap	7	8	7
	Pit	6	7	7
7	Floor	7	7	6
	Heap	7	5	6
	Pit	6	5	6
S.E (±)		0.0001		

stored in a heap were accepted greatly (7.75) while those chips from potatoes stored on the floor were hardly (7.25) accepted yet all were evaluated as liked moderately. This could be attributed to the combined effect of storage conditions and ABA rate on the acceptability of the fried chips. This outcome is in agreement with Lisinska *et al.* (2009); and Saran and Chhabra (2014) who apprised that storage condition and ABA are among the factors that influence the acceptability of fried chips.

Interaction between Storage Conditions and ABA Levels on the Aroma of Fried Potato Chips after Twelve Weeks of Storage

Different ABA rates and storage conditions interacted in a highly significant ($P \leq 0.001$) manner during 12 weeks of storage on the aroma of fried potato chips (Table 13). The dosing of 0 ppm of ABA caused samples stored on a heap to produce potato chips that recorded the largest (7.75) aroma rating though the lowest aroma (6.00) rating was rated as liked moderately and liked slightly correspondingly by sensory evaluators. Samples stored on the floor and heap gave chips with the greatest (7.00 each) aroma rating and rated as liked moderately after increasing the ABA dosage to 2 ppm, least (6.75) aroma value was discovered on chips from potatoes stored in shaded pit storage and the rated as liked slightly. Despite that, adding up ABA doses to 4 ppm stimulated chips from potatoes stored in a heap gave the highest (7.00) aroma value whereas those stored in a shaded pit reported the lowest (6.25) aroma value and were rated as liked slightly. This could be due to the effect of storage condition on fried chips' texture which is congruent to the findings of earlier workers like Jiru and Usmane (2021) who reported a combined influence of storage condition and phytohormone on potato aroma.

Interaction between Storage Conditions and ABA Levels on color of Fried Potato Chips after Twelve Weeks of Storage

A highly significant ($P \leq 0.001$) interaction was discovered throughout the 12 weeks of the study between storage conditions and ABA rates on the color of fried potato chips (Table 14). The treatment of 0 ppm of ABA caused samples stored on the floor to record the best (7.75) colored fried chips and the worst (7.00) colored chips were obtained from samples stored in the shaded pit. Despite that, all were ranked as liked moderately by the sensory analysts. However, treating the samples with 2 ppm of ABA initiated the choicest (8.00) color to emanate again from potatoes stored on the floor though the worst (6.50) color was found again from chips made with potato tubers stored in the shaded pit.

However, a further doubling of ABA level to 4 ppm elicited potatoes stored on the floor to continue providing chips with the best (7.50) color while those stored on the floor and heap storage reported the worst (7.00) color but were both ranked equally as liked moderately. This finding may be attributed to the mixed action of storage condition and ABA level on chips' color as earlier revealed by Saran and Chhabra (2014).

Interaction between Storage Conditions and ABA Levels on Taste of Fried Potato Chips after Twelve Weeks of Storage

The interaction effect of storage conditions and ABA rates during 12 weeks of storage on the taste of fried potato chips is presented in Table 15, a significantly high ($P \leq 0.001$) interaction was unearthed throughout the 12 weeks of the study. The usage of 0 ppm of ABA produced superior (7.50) tasted fried chips which originated from potato samples stored in a heap whilst inferior (6.50) tasted chips were processed from samples stored in the shaded pit. Despite this, they were graded as liked moderately and liked slightly respectively by a panel of sensory judges. However, the usage of 2 ppm of ABA on the samples initiated the most (7.25) preferred taste of chips to stem from potatoes stored on the floor though the least (6.25) preferred taste was found in heap storage that was graded as like moderate and liked slightly accordingly by sensory evaluators. However, a further boost of ABA to 4 ppm encourages potatoes stored on the floor and in the shaded pit to produce the most (7.00 each) preferred taste of chips in contrast those stored on the heap provided the chips with the least (6.75) preferred taste.

The highly significant interaction discovered between storage conditions and ABA rates on the taste of fried potato chips may be attributed to the mixed action of storage conditions and ABA level on the taste of the product. This outcome is in line with Saran and Chhabra (2014) who conveyed that curing and plant hormones affect the color of potato chips.

Interaction between Storage Conditions and ABA Levels on Texture of Fried Potato Chips after Twelve Weeks of Storage

Storage conditions and ABA rates gave a highly significant ($P \leq 0.001$) interaction throughout the 12 weeks of the study on fried potato chip texture as illustrated in Table 16. The application of 0 ppm of ABA caused samples stored in a heap to produce fried chips with the highest (7.25) texture score even though the lowest (6.25) texture score was found on chips from samples stored in the shaded pit that were rated as liked moderately and liked slightly respectively by a panel of sensory assessors. Yet, raising the ABA level to 2 ppm produced chips with the same texture (6.25 each) score for the three storage conditions under review. Moreover, a further raised in ABA level to 4 ppm again maintained the same trend of equal texture (6.25) score for all three storage conditions.

The interaction effect of storage conditions and ABA rates on the texture of fried potato chips may be due to the amalgamated role of the two factors under study on the taste of fried chips. A similar position was advocated by Saran and Chhabra (2014); and Jiru and Usmane (2021).

Interaction between Curing Periods, Storage Conditions, and ABA Levels on Acceptability of Fried Potato Chips after Twelve Weeks of Storage

A highly significant ($P \leq 0.001$) interaction was demonstrated between curing periods, storage conditions, and ABA rates on the acceptability of fried potato chips at the end of the storage period as illustrated in Table 17. Fried potato chips made from potato tubers subjected to zero curing period, stored in a heap and shaded pit treated with 0 ppm of ABA indicated top most figures (9) for acceptability and ranked liked extremely with bottom-most figures (7) for acceptability originating from fried chips processed from potato tubers cured for zero days stored on the floor that was ranked as liked moderately by the panel of sensory analysts.

A consequent increase in ABA rate to 2 ppm displayed top most figures (9) on chips from potato tubers cured for five days and stored on the floor but bottom most figures (6) were noticed on fried chips obtained from potato tubers cured for three days and again stored on floor. They were ranked as liked extremely and liked moderately correspondingly.

Subsequent addition of ABA to 4 ppm, potato tubers cured for five days and stored inside a shaded pit depicted fried chips with the topmost figures (9). Simultaneously, the bottommost figure (5) came from chips made with potato tubers cured for zero days and stored on the floor that was ranked liked extremely and neither liked nor disliked respectively.

A highly significant interaction was demonstrated between curing periods, storage conditions and ABA rates on the acceptability of fried potato chips at all the sampling periods could be due to the melded effect of the curing period, storage condition, and ABA rate. This is in line with Saran and Chhabra (2014); and Juri and Usmane (2021) who reported that the sensory quality of processed potato tubers is significantly affected by curing periods, storage conditions, and plant hormones.

Interaction between Curing Periods, Storage Conditions, and ABA Levels on Aroma of Fried Potato Chips after Twelve Weeks of Storage

Table 18 presented a highly significant (P≤0.001) interaction between curing periods, storage conditions and ABA rates on the aroma of fried potato chips at the end of the sampling periods. A treatment of 0 ppm of ABA-produced fried potato chips made from potato tubers subjected to zero curing period and floor storage gave the highest aroma score of 9 and was rated as liked extremely by the panel of sensory assessors. Concurrently, the lowest aroma score of 4 was obtained on fried chips processed from potato tubers cured for seven days and stored in shaded pit which was rated as disliked slightly by the assessors.

A further upsurge in ABA rate to 2 ppm resulted in chips from potato tubers cured for zero days curing period under all storage conditions to supply the highest aroma score of 8 and rated as like very much by assessors. At the same time, the lowest scores of 6 were recorded on fried chips obtained from potato tubers cured for three days stored on the floor, five days stored in a heap and seven days stored again in the heap that was all rated equally as liked slightly.

A supplementary intensification of ABA to 4 ppm caused potato tubers cured for zero and three days and both stored in a heap provided fried chips with the highest scores (8) and rated liked very much. On the other hand, the lowest scores (5) were found on chips made with potato tubers cured for zero and five both stored on the floor and so also seven days curing with shaded pit storage that were all rated equally as neither liked nor disliked.

This may be due to the fused role of the curing period, storage condition, and ABA level on the aroma. This result is similar to Saran and Chhabra (2014); and Juri and Usmane (2021) who observed that the sensory quality of potato chips could be influenced by curing periods, storage conditions and plant growth regulators.

Interaction between Curing Periods, Storage Conditions and ABA Levels on color of Fried Potato Chips after Twelve Weeks of Storage

The interaction between curing periods, storage conditions and ABA rates on the color of fried potato chips at the end of the storage period showed a highly significant (P≤0.001) interaction as shown in Table 19. A dosage of 0 ppm of ABA produced fried potato chips with the greatest (9) color ranking from potato tubers subjected to zero curing period and stored in a heap and shaded pit. Relatedly, three days of curing with heap storage also gave an equal color ranking of 9 that were all termed as liked extremely grade according to sensory evaluators. The lowest ranked color of 6 was obtained on fried chips made from potato tubers cured for seven days coupled with shaded pit storage which was regarded as liked slightly by the evaluators.

A consequential rise in ABA rate to 2 ppm resulted in chips from potato tubers cured for zero days under floor and shaded pit storage conditions, tubers cured for three days stored In heap and shaded pit likewise five days curing with floor and heap storage recorded the highest (8) ranking and graded as liked very much by evaluators. Nonetheless, the lowest (5) color ranking was noted on fried chips from potato tubers cured for seven days together with shaded pit storage and was graded as neither like nor dislike.

In furtherance, magnification of ABA to 4 ppm led potato tubers cured for zero days and stored in heap and shaded pit, three days curing with both floor and heap storage and finally seven days curing with storage on floor delivered fried chips with the highest (8) color ranking. On the other hand, the lowest score (4) was affirmed by chips prepared from tubers cured for five days and stored in a heap which were graded as liked very much and disliked slightly respectively by the panel of sensory judges.

This outcome may be due to the joint effect of curing periods, storage conditions and ABA rate on the taste of fried chips which concurred with Saran Chhabra (2014); Jiru and Usmane (2021) who related that curing periods, storage conditions and ABA are among the major determinant of potato chips color.

Interaction between Curing Periods, Storage Conditions and ABA Levels on Taste of Fried Potato Chips after Twelve Weeks of Storage

Curing periods, storage conditions and ABA rates interacted in a highly significant (P≤0.001) way with the taste of fried potato chips during the experiment (Table 20). The application of 0 ppm of ABA to potato tubers exposed to various curing periods and storage conditions created fried potato chips from tubers treated with zero days curing period stored under shaded pit storage, three days curing period stored on floor and heap. Lastly, a five-day curing period was stored on floor storage to give the greatest taste grades of 8 which were graded as liked very much by sensory panelists. The least taste grade of 5 was obtained from fried chips derived from potato tubers cured for seven days in conjunction with shaded pit storage that was considered neither liked nor disliked by the sensory panelists.

An increment in ABA rate of 0 ppm to 2 ppm made chips from potato tubers cured for zero, three and five days together with shaded pit, floor and heap storage respectively documented the greatest (8) grade that was deemed as like very much by a panel of sensory judges. Nevertheless, the lowest (5) grade was registered on fried chips from potato tubers cured for seven days and kept in heap storage which was graded as neither liked nor disliked.

Moreover, an amplification from 2 ppm to 4 ppm ABA directed potato tubers cured for zero and three days stored on the floor, shaded pit and heap to present fried chips with the greatest (8) grade respectively and judged as liked very much. On the contrary, the least (4) grade was confirmed by chips made from tubers cured for five days stored in a heap and was acknowledged as disliked slightly. These interactions could be attributable to the combined effect of all three factors under consideration which is also in conformity with the finding of Jiru and Usmane (2021) who reported that the collaborative impact of curing periods, storage conditions and ABA affects the taste of chips.

Interaction between Curing Periods, Storage Conditions and ABA Levels on Texture of Fried Potato Chips after Twelve Weeks of Storage

There was a highly significant ($P \leq 0.001$) interaction among the three factors on the texture of fried potato chips at the terminal end of the study as portrayed in Table 21. The spraying of potato tubers with 0 ppm of ABA which were subjected to various curing periods and storage conditions, caused fried potato chips with the biggest (9) texture mark to originate from potato tubers exposed to zero curing period plus shaded pit storage, which was marked as liked extremely by the sensory appraisers. However, the smallest (6) texture mark was developed from fried chips prepared from potato tubers cured for three, five and seven days in combination with shaded pit storage which was regarded as liked slightly by the appraisers.

A boost in ABA rate from 0 ppm to 2 ppm made chips from potato tubers cured for zero days with both heap and shaded pit storage, similarly five days stored in also heap gave the biggest (8) texture mark that was appraised as liked very much by a panel of sensory appraisers. All the same, the smallest (5) mark was conveyed by fried chips from potato tubers cured for three stored on the floor, and seven days kept in a heap and shaded pit, were appraised as neither liked nor disliked.

Further fortification of ABA from 2 ppm to 4 ppm led potato tubers cured for zero as well as stored in a heap to reveal fried chips with the biggest (8) textural mark and was appraised as liked very much. On the other hand, the smallest (5) mark was established by chips prepared from tubers cured for zero and three days both stored on the floor which was appraised as neither liked nor disliked.

This outcome could be attributable to the collective influence of curing periods, storage conditions and ABA as claimed earlier by Jiru and Usmane (2021) who found that chips processed from tubers cured for seven days in combination with floor and heap storage affected texture.

CONCLUSION

In conclusion, this study found that curing, ABA and storage conditions have a very highly significant influence on the organoleptic quality of fried potato chips after storage for 12 weeks under ambient conditions. Thus, for the best sensory quality of fried potato chips in the study area, tubers should be treated with 4 ppm ABA, cured for seven days and stored under a shaded pit storage method.

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APPENDIX

Appendix I. A 9-Point Hedonic Scale for Potato Sensory Evaluation

	Attributes				
Point	**Acceptability**	**Aroma**	**Colour**	**Taste**	**Texture**
9	Like Extremely	Like Extremely	Like Extremely	Like Extremely	Like Extremely
8	Like Very Much	Like Very Much	Like Very Much	Like Very Much	Like Very Much
7	Like Moderately	Like Moderately	Like Moderately	Like Moderately	Like Moderately
6	Like Slightly	Like Slightly	Like Slightly	Like Slightly	Like Slightly
5	Neither Like or Dislike	Neither Like or Dislike	Neither Like or Dislike	Neither Like or Dislike	Neither Like or Dislike
4	Dislike Slightly	Dislike Slightly	Dislike Slightly	Dislike Slightly	Dislike Slightly
3	Dislike Moderately	Dislike Moderately	Dislike Moderately	Dislike Moderately	Dislike Moderately
2	Dislike Very Much	Dislike Very Much	Dislike Very Much	Dislike Very Much	Dislike Very Much
1	Dislike Extremely	Dislike Extremely	Dislike Extremely	Dislike Extremely	Dislike Extremely

(Source: SSP, 2019)