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SORPTION ISOTHERM AND QUALITY ASSESSMENT OF CHICKEN JERKY

Oluwatoyin Folake Alamuoye[1], Nathaniel Olu Alamuoye[2*], Lawrence Kunle Otitoju[3]
[1]Animal Science Department, Faculty of Agricultural Science, Ekiti State University, Ado Ekiti, Nigeria.
[2]Food Science and Technology Department, School of Agriculture and Agricultural Technology, Bamidele Olumilua University of Education Science and Technology, Ikere Ekiti, Nigeria.
[3]Food Science and Technology Department, School of Agriculture and Agricultural Technology, Bamidele Olumilua University of Education Science and Technology, Ikere Ekiti, Nigeria.

[*]Corresponding Author

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ABSTRACT
This study investigated the sorption isotherm, proximate composition, lipid oxidation, and sensory evaluation of chicken jerky. The moisture adsorption behavior was analyzed using a gravimetric method while proximate analysis was performed according to official methods. Lipid oxidation was measured by thiobarbituric acid reactive substances (TBARS) assay while sensory evaluation was conducted with trained panelists based on appearance, taste, odor, texture, and overall acceptability. Results showed that equilibrium moisture content increased as water activity increased from 0.043 to 0.750 but remained relatively constant at 0.843 to 0.973 a_w*. Proximate analysis revealed that the protein content of chicken jerky was high (76.13) while a low-fat content (1.72%) was obtained in this study. Sensory evaluation indicated that overall acceptability was highly dependent on texture followed by aroma and flavour. Based on these results it can be concluded that factors such as formulation, processing method, ingredient quality and raw meat quality greatly influence the physicochemical properties of chicken jerky which ultimately affects consumer acceptance.*
KEYWORDS: *Aroma, Humidity, Salt,Shelf-life, Snack, Storage*

INTRODUCTION

Chicken jerky is a popular type of meat snack that is typically made from thinly sliced chicken meat that has been marinated and dried (Nam et al., 2017). The process of making chicken jerky involves removing excess moisture from the meat through dehydration, which helps to preserve the meat and enhance its flavor (Kim et al., 2021). Chicken jerky is often seasoned with a variety of spices and seasonings to add flavor and enhance the overall taste of the final product (Kurniawan et al., 2023). This type of jerky is known for its chewy texture and savory flavor, making it a favorite snack choice for many consumers (Rini et al., 2021). Studying the characteristics of chicken jerky is crucial for various reasons. The understanding of the sorption isotherm of chicken jerky helps in determining its moisture content at different relative humidity levels, which is essential for maintaining its quality and shelf life (Kaur et al 2023). Additionally, analyzing the proximate composition of chicken jerky provides valuable information about its nutritional content, such as protein, fat, and carbohydrate levels, which is important for consumers who are conscious of their dietary intake. Information on lipid oxidation in chicken jerky is critical for evaluating its oxidative stability and preventing rancidity, ensuring a pleasant taste and longer storage life. Lastly, assessing the organoleptic quality of chicken jerky, including its texture, flavor, and overall acceptability, helps in determining consumer preferences and market demand (Zhigalova et al., 2021). Overall, thorough research on the characteristics of chicken jerky is essential for improving product quality, ensuring consumer satisfaction, and driving the growth of the poultry industry

A Sorption isotherm is a graphical representation that shows the relationship between the amount of water absorbed by a material and the water activity of the surrounding environment. In the context of chicken jerky production, understanding the sorption isotherm is crucial for determining the moisture content of the finished product and predicting its stability during storage (Aviara, 2020). By studying the sorption isotherm of chicken jerky, researchers can gain insights into the binding mechanisms of water molecules within the product matrix, which in turn affects its texture, shelf life, and overall quality (Hüfner-Wulsdorf and Klebe, 2020). This information is particularly important for optimizing the production process and ensuring consistent product quality for consumers.

Factors affecting the sorption isotherm of chicken jerky include temperature, relative humidity, and the composition of the jerky itself. Temperature plays a crucial role in sorption behavior, as lower temperatures can lead to increased moisture uptake by the product (Masum et al ., 2020). The relative humidity of the surrounding environment also has a significant impact, with higher humidity levels resulting in greater moisture absorption by the jerky (Kubochkin and Ivanova, 2019). Additionally, the composition of the chicken jerky, particularly its protein and fat content, can influence the sorption isotherm, affecting how the product interacts with water molecules. Understanding these factors is essential for optimizing the shelf life and organoleptic quality of chicken jerky products.

Sorption isotherm plays a crucial role in understanding the moisture sorption behavior of food products, including chicken jerky (Caballero-Cerón, 2015). The relationship between moisture content and water activity at equilibrium, can be used to determine the optimal storage conditions to maintain product quality and shelf-life. Sorption isotherm data can also be utilized to develop predictive models for moisture migration, which is essential for preventing quality defects such as lipid oxidation in chicken jerky (Cao et al., 2020) and also to design packaging materials that regulate moisture transfer, leading to improved organoleptic quality and consumer satisfaction.

Proximate analysis is a crucial aspect of food evaluation as it provides valuable information about the composition and nutritional content of food products. By analyzing the proximate components, such as moisture, protein, fat, ash, and fiber, food scientists can assess the overall quality and safety of a food item (Thangaraj, 2016). In the case of chicken jerky, proximate analysis is essential in understanding the moisture content, protein levels, and lipid composition of the product. This information is vital for ensuring the product meets regulatory standards and consumer expectations. Additionally, proximate analysis allows researchers to determine the shelf stability and potential for lipid oxidation in chicken jerky, which can impact the overall organoleptic quality of the product. Therefore, conducting thorough proximate analysis is critical in evaluating the nutritional value and overall quality of food products like chicken jerky.

Understanding lipid oxidation is crucial in the food products, especially when it comes to the development of processed meat products like chicken jerky. Lipid oxidation is a complex process that involves the degradation of lipids in the presence of oxygen (Ito, 2019), leading to the formation of off-flavors, off-odors, and potentially harmful compounds (Wu, 2022). Lipid oxidation can significantly impact the shelf-life and overall quality of the product. Therefore, it is essential to carefully monitor and control lipid oxidation throughout the production process to ensure the safety and sensory acceptability of the final product. Factors such as temperature and light exposure, can also impact the rate of lipid oxidation in meat products, ultimately affecting their quality and shelf life. Oxidized lipids do not only lead to off-flavors and rancid odors but also result in a reduction of shelf life due to the formation of harmful compounds such as malondialdehyde. Furthermore, the presence of oxidized lipids can have detrimental effects on consumer health, as these compounds have been linked to various chronic diseases, including cancer and cardiovascular disorders (Anghel and Trifănescu, 2019). It is therefore essential to monitor and control lipid oxidation in chicken jerky products to ensure they meet both quality standards and regulatory requirements.

Organoleptic quality refers to the sensory properties of a food product that can be perceived by the human senses, including taste, aroma, texture, and appearance. These sensory attributes play a crucial role in determining the overall acceptability and palatability of a food product. Consumers often rely on their sensory perceptions to evaluate food products, making organoleptic quality a key consideration in determining consumer preference and satisfaction. This study will investigate sorption isotherms as a valuable tool for product stability and factors affecting the quality of chicken jerky, ultimately contributing to the development of improved processing techniques and storage conditions for this popular snack product.

MATERIALS AND METHODS

The chickens used for this experiment were selected from Teaching and Research farm of Ekiti State University, Ado Ekiti, Nigeria.

PROCEDURE OF ADSORPTION

The equilibrium moisture content of chicken jerky was determined at 25 °C using the static gravimetric method (Mallek-Ayadi et al., 2020). Ten grams of chicken jerky were placed in a plastic mesh bag, which was dropped above the saturated salt solution contained in a glass jar. The jar was tightly closed and placed in a temperature-controlled cabinet (±0.2 °C). The sample was weighted daily until the mass difference was less than 0.001g. To determine the equilibrium moisture content, the sample was dried at 105 °C for 24 h. All the experiments were carried out in triplicate. Ten saturated salt solutions were prepared with a range of 0.043 to 0.973. The salt solutions used and their matching water activities were as reported (Greenspan, 1977) and this is as given in Table 1.

Table 1 Salts and water activities

Salts	Aw (25^0C)
Cesium Fluoride	0.043
Lithium Chloride	0.113
Potassium Acetate	0.225
Magnesium Chloride	0.328
Potassium Carbonate	0.432
Sodium Bromide	0.576
Potassium Iodide	0.689
Sodium Chloride	0.753
Potassium Chloride	0.843
Potassium Sulfate	0.973

Determination of equilibrium moisture content is as stated below:

$EMC = \frac{wf-wi}{wi}$ x 100 (AOAC, 2010)

………………………… Equation 1

The GAB equation which is mostly suitable for a_w of 0 - 0.95 [Mustafa, 2018], was used to determine the water activity and monolayer moisture value of the product.

GAB Equation = $= \frac{M}{Mm} = \frac{ABaw}{(1-Baw)(1-Baw+ABaw)}$ (Van Den Berg, 1985)

………………………… Equation 2

GAB equation was rearranged into second degree polynomial for the determination of water activity and monolayer moisture value.

Mo – Monolayer value = $1/\sqrt{b^2 - 4ac}$ ………………………… Equation 3

$a_w = a_w/M$ = Equation of line=y ………………………… Equation 4

Y= a_w/M (M= Monolayer value) Monolayer value indicates the amount of water that is strongly adsorbed in specific sites, and it is considered to be the value at which a food product is the most stable.

METHODOLOGY FOR CHICKEN JERKY PREPARATION

Fresh 2.5 kg of boneless and skinless chicken breast was thinly sliced to ensure even cooking and maximum flavor absorption. A marinade was prepared using a combination of non -meat ingredients (1 table spoon of chili pepper, 1 table spoon black pepper, 1 table spoon garlic powder, 1 tea spoon of onion paste,1 table spoon of rosemary,1 tea spoon of thyme, 1 tea spoon of curry powder, half tea spoon of salt and 150ml of soy-sauce) to enhance the taste of the jerky. The chicken slices were marinated with the prepared ingredients, covered with polythene and chilled at 7ºC for 24 hrs. Marinated chicken slices were spread on the oven rack, allowed to totally drain before transferred to oven for drying at 70^0 C for 8 hours. The dried chicken jerky was cooled and stored in an airtight container to maintain freshness prior analysis.

LIPID OXIDATION ANALYSIS OF CHICKEN JERKY

Lipid oxidation was analyzed using the thiobarbituric acid reactive substances (TBARS) assay to measure malondialdehyde (MDA) levels as a marker of lipid oxidation (Zeb and Ullah, 2016)

SENSORY PROPERTIES EVALUATION

The sensory properties evaluation in this study involved a trained panel of ten individuals who underwent rigorous training to ensure consistency and reliability in their assessments. Each panelist was provided with specific criteria for evaluating attributes such as appearance, color, aroma, taste, texture, and overall acceptability of the chicken jerky samples. The samples were presented in a random order to prevent bias in the evaluation process. All sensory evaluations were conducted in a controlled environment following standardized protocols to minimize external influences on the panelists' judgments. Samples were coded and independently evaluated using a 9- point hedonic scale ranked as follows; like extremely to very much (8–9 scores), like moderately to like slightly (5–7 scores), neither like nor dislike to dislike slightly or dislike moderately (2–4 scores) and dislike extremely to dislike very much (0–1 score) for aroma, flavor, tenderness, texture and over all- acceptability (Peryam and Girardot, 1952)

PROXIMATE COMPOSITION DETERMINATION OF CHICKEN JERKY

The proximate composition of the chicken jerky samples was determined according to the methods outlined by the Association of Official Analytical Chemists (AOAC). The samples were first analyzed for moisture content using the oven-drying method. The protein content was determined by the Kjeldahl method, while the

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lipid content was assessed using the Soxhlet extraction method. Finally, the ash content was measured by incinerating the samples at high temperatures. In order to ensure the accuracy and reliability of the results, all analyses were conducted in triplicate (Horwitz and Latimer, 2011).

STATISTICAL ANALYSIS

1. Statistical analysis was carried out using IBM SPSS Statistics 20, One-way ANOVA Post Hoc Multiple Comparisons of Ryan-Einot-Gabriel-Welsch F' test at 0.05 significance level (SPSS Statistics, 2011)

RESULTS AND DISCUSSION

The results of sorption isotherm are as presented in Table1. Equilibrium moisture content ranged between 13.23 to 42.85 with highest water activity of moisture recorded at the highest relative humidity (97.3%). The fitness of sorption curve was appropriate at 0.8473 (Figure 1). Water activity of this product was 0.371a_w with a monolayer value of 26.95 (g H_20/g solid). (Table 3). The proximate analysis of chicken jerky which involved determination of moisture, protein, fat, and ash content showed that the moisture content of chicken jerky had 10.53%. Protein, fat and ash content recorded 76.13, 1.72 and 8.17 % respectively. These results indicate that chicken jerky is a high-protein and low-fat snack meat product. The results of lipid oxidation and sensory evaluation showed that the product is of good quality (Table 5&6)

Table 2: Sorption Isotherm of Chicken Jerky

Aw (25^0C)	Adsorption			
	EMC (M) (%)		SD	Aw/M
0.043	13.23	±	0.09	0.00325
0.113	14.36	±	0.06	0.00786
0.225	16.5	±	0.05	0.01363
0.328	18.65	±	0.05	0.01758
0.432	26.45	±	0.04	0.01633
0.576	37.75	±	0.15	0.01526
0.689	39.12	±	0.06	0.01762
0.753	40.45	±	0.15	0.01862
0.843	42.55	±	0.22	0.01981
0.973	42.85	±	0.15	0.02271

EMC = M = Equilibrium Moisture Content

Figure 1: Adsorption Isotherm Curve of Chicken Jerky

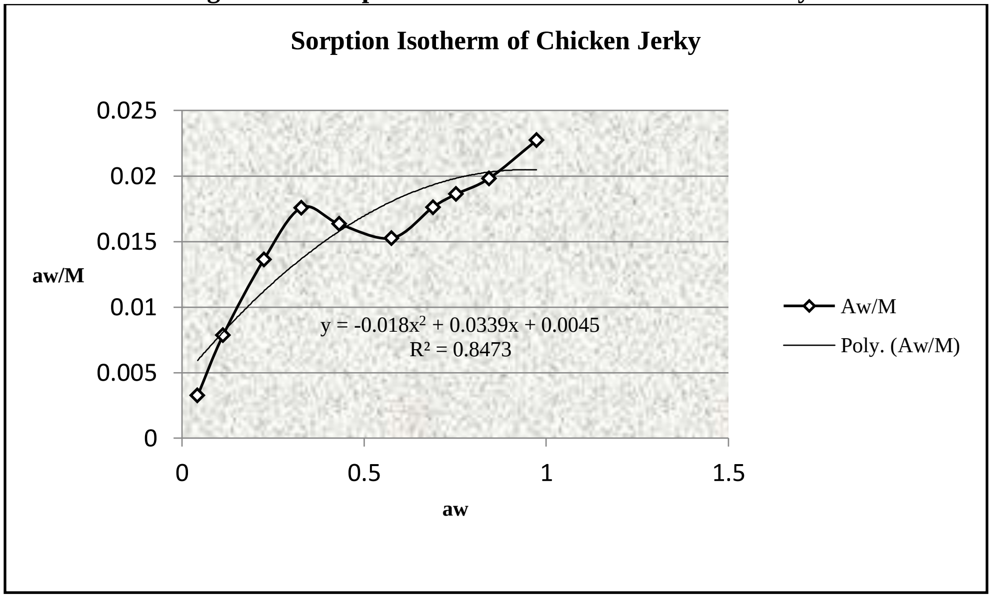

Table 3 Analysis of sorption data of Chicken Jerky according to GAB Model

Product sample	Water activity (a_w)	Monolayer value (Mo) (g H_20/g Solid)	R^2
Chicken Jerky	0.371	26.95	0.847

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Figure 2: Sample of Chicken Jerky

Table 4 Proximate composition of processed chicken Jerky (%)

Components	Composition	SD
Crude protein	76.13	0.15
Moisture content	10.53	0.07
Ash	8.17	0.17
Fat	1.72	0.04
Carbohydrate	3.45	0.12

SD- standard deviation of mean

Table 5 Lipid Oxidation of chicken jerky in storage

Days	TBARS (MDA/Kg meat)	SD
1	0.1100^{a}	0.0100
7	0.1133^{a}	0.0577
14	0.1667^{b}	0.0577
21	0.2100^{c}	0.0200
28	0.2300^{c}	0.0100

TBARS- Thiobarbituric Acid-Reactive Substance, SD- standard deviation of mea

Table 6 Sensory properties of processed chicken Jerky

	Mean Value	SD
Flavour	5.83	0.08
Aroma	6.33	0.05
Juiciness	4.00	0.10
Texture	6.66	0.12
Tenderness	4.33	0.05
Overall acceptability	7.33	0.07

SD- Standard Deviation Of Mean

The relationship between moisture content and sorption isotherm is a crucial aspect to consider when analyzing the behavior of materials in different humidity environments. In the study of chicken jerky, the moisture content of the product directly impacts its ability to absorb water vapor from the surrounding atmosphere, as shown by changes in the sorption isotherm. The correlation between these two factors can provide valuable insights into the stability and shelf-life of the jerky product. By understanding the correlation between moisture content and sorption isotherm, researchers can make informed decisions regarding optimal storage conditions and packaging methods to maintain the desired organoleptic properties of Chicken Jerky.

The impact of protein and fat content on sorption isotherm is key in the study of chicken jerky (Domian et al., 2018). The relatively high protein content of chicken jerky recorded in this study can influence the water-holding capacity and overall texture of the product, affecting its sorption isotherm behavior (Li et al., 2021). On the other hand, the fat content of the jerky can play a role in lipid oxidation, which can impact both the sorption isotherm and organoleptic quality of the product (Han et al., 2019). The understanding of how these two macronutrients interact with water molecules during storage can enable the formulation of chicken jerky to ensure both a longer shelf-life and superior sensory attributes.

The relationship between ash content and sorption isotherm in chicken jerky is a complex interplay that requires careful analysis. Ash content, which represents the mineral content of the jerky, can impact the water-holding capacity and porosity of the product, thereby influencing its sorption behavior (Cheng and Sun, 2008). The ash content of 8.17% obtained in this study may lead to increased water absorption, affecting the equilibrium moisture content at different relative humidities. This interaction between ash content and sorption isotherm highlights the importance of understanding the composition of chicken jerky and its implications for product quality and shelf life.

The comparison of sorption isotherm and proximate analysis results revealed important insights into the moisture content and chemical composition of Chicken Jerky. The sorption isotherm data provided valuable information about the moisture absorption behavior of the jerky, while the proximate analysis results detailed the protein, fat, ash, and carbohydrate content of the product. By examining these two sets of data together, we were able to establish a comprehensive understanding of the physical and chemical properties of the Chicken Jerky sample, which is crucial for assessing its overall quality and shelf stability. The low monolayer moisture content which refers to the amount of water absorbed per unit volume of chicken jerky shows that this product will be stable at the monolayer value of 26.95 (g H_20 / g solid) and at water activity below the determined water activity of 0.371 (Arslan-Tontul, 2020)

Lipid oxidation in chicken jerky can have a significant impact on its flavor profile (Silva et al., 2018). As the lipids in the jerky undergo oxidation, they can produce off-flavors and aromas that are often described as rancid or stale. These oxidative changes can not only alter the taste of the jerky but also affect its overall sensory appeal to consumers. Lower levels of lipid oxidation in this chicken jerky under study can indicate with high quality and freshness, ultimately influencing consumer preferences and purchase decisions.

The impact of lipid oxidation on the texture of chicken jerky is a critical consideration in the production of this popular snack (Amaral et al., 2018). Lipid oxidation can lead to changes in flavor, color, and texture of chicken jerky that is unappealing to consumers. Therefore, by understanding the factors that contribute to lipid oxidation and implementing strategies to minimize its effects, producers can maintain the desired texture and quality of chicken jerky for improved consumer satisfaction and market success.

Processing methods play a crucial role in enhancing the organoleptic quality of food products such as chicken jerky (Shi et al., 2020). The way in which the chicken jerky is prepared, cooked, and preserved can greatly impact its taste, texture, aroma, and overall sensory attributes. For example, different marinating techniques, smoking methods, and drying processes can all contribute to the final organoleptic characteristics of the chicken jerky. By carefully selecting and applying appropriate processing methods, manufacturers can improve the palatability and consumer acceptance of their products, ultimately leading to increased market success and customer satisfaction. In this study, oven drying method enhanced good organoleptic properties which can improve consumer perception of the organoleptic quality of the product. Optimizing factors such as moisture content, lipid oxidation, and color in chicken jerky, can significantly enhance the overall organoleptic quality of the product, making it more appealing to consumers.

In the study on Chicken Jerky, natural antioxidants were used to inhibit the lipid oxidation process, which can lead to off-flavors and rancidity in meat products. Antioxidants compounds that protect cells from the damaging effects of oxidative stress (Sies, 2020) caused by free radicals, contained in the spices (chili pepper, black pepper, garlic powder, onion paste, rosemary, thyme and curry powder) used in the preparation of chicken jerky in this study may have played a crucial role in preventing lipid oxidation and maintaining the organoleptic quality of the product. Antioxidants are known to help stabilize lipids and improve the shelf life of meat products by delaying the onset of lipid oxidation which can negatively impact the taste and smell of the jerky (Chib et al., 2020). Overall, the incorporation of antioxidants in the production process of Chicken Jerky is essential for maintaining product quality and consumer satisfaction.

RECOMMENDATION

Based on the sorption isotherm analysis conducted on chicken jerky, it is recommended that the product be stored in a controlled environment with low humidity levels to prevent moisture uptake and potential spoilage. The sorption isotherm data revealed that the equilibrium moisture content of the jerky increased significantly at higher relative humidity levels, indicating the product's susceptibility to moisture absorption from the surrounding environment. To ensure the quality and shelf life of the chicken jerky, it is crucial to store it in moisture-proof packaging or in a dry environment to minimize the risk of spoilage and lipid oxidation. These storage recommendations aim to maintain the organoleptic quality and extend the shelf life of chicken jerky products.

Moving forward, it is recommended that future research in the field of chicken jerky production should focus on exploring additional factors that may influence sorption isotherm, proximate composition, lipid oxidation, and organoleptic quality. Further studies could investigate the impact of different marination techniques on the quality attributes of chicken jerky, as well as the use of natural antioxidants in extending the shelf-life of the product.

CONCLUSION

The summary of findings from the study on the sorption isotherm, proximate analysis, lipid oxidation, and organoleptic quality of Chicken Jerky indicated that the sorption isotherm of the jerky followed a typical sigmoid curve of type II , revealing an increase in equilibrium content with increase in relative humidity. Proximate analysis showed that the jerky had a high protein content and relatively low-fat content, making it a potentially healthy snack option. Lipid oxidation levels were found to be within acceptable limits, suggesting good shelf stability of the product. Organoleptic evaluations revealed that the Chicken Jerky will be well-liked by consumers in terms of flavor, texture, and overall satisfaction. Overall, the findings suggest that Chicken Jerky could be a promising product for the market.
In conclusion, the study on the sorption isotherm, proximate analysis, lipid oxidation, and organoleptic quality of chicken jerky provides valuable insights into the shelf-life and sensory properties of this popular snack.

CONFLICTS OF INTEREST

The authors declare that there is no conflict of interest.

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