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Effect of Different Onion Skin Extracts on Physicochemical, Microbial and Sensory Properties of Grilled Chicken

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Abstract

Solvent and extraction methods have been established as one of the determinant of extract yield and its components. These influence the amount of phenolic compounds in the extracts that inhibit microbial growth in meat products during storage. However, the influence of different solvent extraction on grilled chicken has not been documented. Hence, the physicochemical, microbial and sensory properties of grilled chicken marinated in different onion skin solvent extraction were investigated. Ground Onion Skin-OS (0.25kg) was soaked in a litre of distilled water (45^{o}C) for 24 hr. For ethanolic and methanolic extraction, ground OS (0.25kg) was soaked in a litre of 80% of each solvent for 24 hr. Extracts were filtered and concentrated using water bath. The yield was determined and extracts were stored. Nine broiler birds (1.9±0.2 kg) were slaughtered, defeathered and the breast portions were removed. Water, ethanol and methanol OS extract (3g each) representing three treatments were added each separately to 1 liter of water in three replicates. Each chicken breast was immersed in each container and stored at 4^{o}C for 24 hr after which the meats were grilled in the oven at 250^{o}C for 30min. Physicochemical and sensory properties of the grilled meats were determined after which the products were stored at 4^{o}C for six days for microbial evaluation on day 0, 3 and 6. The OS extract yield from water was higher while the lower yield was recorded in methanolic extract. Microbial load of grilled chicken increased during storage with all extracts except for ethanol on day 3. Methanolic extract of OS significantly reduced microbial load compared to water and ethanol except for day 3 where extracts had similar effect (P>0.05) on grilled meat. While pH was not significantly affected by the treatments, cooking loss (%) in methanolic extraction (45.06) was significantly higher than water (50.99) and ethanolic (48.56) OS extracts. Cooking yield (%) had higher value in methanolic extraction (54.94) compared to water (50.99) and ethanol (51.44) OS extracts. While other sensory properties were not significantly affected, flavour (4.43) and juiciness (6.35) of grilled chicken from OS methanolic extract were higher than other treatments. Grilled chickens from water (5.67) and methanolic (5.34) OS extracts were more acceptable to the taste panelists. Extraction with water increased the yield of onion skin extract while methanolic extraction reduced microbial load and improved the physicochemical and sensory properties of grilled chicken.

Keywords: Onion Skin, extraction methods, sensory, physicochemical, grilled chicken

Effet De Differents Extraits De Pelure D'oignon Sur Les Proprietes Physiochimiques, Microbiennes Et Sensorielles Du Poulet Grille

Résumé

Les méthodes de solvant et d'extraction ont été établies comme l'un des déterminants du rendement de l'extrait et de ses composants. Ceux-ci influencent la quantité de composés phénoliques dans les extraits qui inhibent la croissance microbienne dans les produits carnés pendant le stockage. Cependant, l'influence de différents solvants d'extraction sur le *poulet grillé n'a pas été documentée. Par conséquent, les propriétés physicochimiques, microbiennes et sensorielles du poulet grillé mariné dans différentes extractions au solvant de peau d'oignon ont été étudiées. Pelure d'oignon de basse- PO (0,25 kg) a été trempé dans un litre d'eau distillée (45oC) pendant 24 heures. Pour l'extraction éthanolique et méthanolique, le PO broyé (0,25 kg) a été trempé dans un litre de 80 % de chaque solvant pendant 24 heures. Les extraits ont été filtrés et concentrés à l'aide d'un bain-marie. Le rendement a été déterminé et les extraits ont été stockés. Neuf poulets de chair (1,9 ± 0,2 kg) ont été abattus, plumés et les morceaux de poitrine ont été retirés. L'eau, l'éthanol et l'extrait de méthanol PO (3 g chacun) représentant trois traitements ont été ajoutés chacun séparément à 1 litre d'eau en trois répétitions. Chaque poitrine de poulet a été immergée dans chaque récipient et stockée à 4oC pendant 24 heures, après quoi les viandes ont été grillées au four à 250oC pendant 30 minutes. Les propriétés physicochimiques et sensorielles des viandes grillées ont été déterminées, après quoi les produits ont été stockés à 4oC pendant six jours pour une évaluation microbienne aux jours 0, 3 et 6. Le rendement de l'extrait PO à partir de l'eau était plus élevé tandis que le rendement inférieur était enregistré dans l'extrait méthanolique. La charge microbienne du poulet grillé a augmenté pendant le stockage avec tous les extraits à l'exception de l'éthanol au jour 3. L'extrait méthanolique de PO a considérablement réduit la charge microbienne par rapport à l'eau et à l'éthanol, sauf au jour 3 où les extraits ont eu un effet similaire (P> 0,05) sur la viande grillée. Bien que le pH n'ait pas été significativement affecté par les traitements, la perte à la cuisson (%) dans l'extraction méthanolique (45,06) était significativement plus élevée que dans les extraits de PO à l'eau (50,99) et à l'éthanol (48,56). Le rendement de cuisson (%) avait une valeur plus élevée dans l'extraction méthanolique (54,94) par rapport aux extraits PO à l'eau (50,99) et à l'éthanol (51,44). Alors que les autres propriétés sensorielles n'étaient pas significativement affectées, la saveur (4,43) et la jutosité (6,35) du poulet grillé à partir d'extrait méthanolique PO étaient plus élevées que les autres traitements. Les poulets grillés à partir d'extraits aqueux (5,67) et méthanoliques (5,34) PO étaient plus acceptables pour les dégustateurs. L'extraction à l'eau a augmenté le rendement de l'extrait de peau d'oignon tandis que l'extraction méthanolique a réduit la charge microbienne et amélioré les propriétés physicochimiques et sensorielles du poulet grillé.*

Mots-clés : Pelure d'oignon, méthodes d'extraction, sensoriel, physico-chimique, poulet grillé

Introduction

For many years, experts in the global meat business have been attempting to tackle the problem of meat product safety and determining the best approaches to maintain acceptable consumer preference throughout the shelf life. A variety of strategies have been devised for extending the shelf life of the completed meat product, including barrier packaging, low temperatures, preservatives and antioxidants (Sunniva *et al*., 2022; Majeed *et al*.,2022; Zhang *et al*., 2022). The most common types of deterioration to beef products during storage are microbiological and oxidative (Dave and Ghaly, 2011). The product's biological value deteriorates, as do its qualities such as colour, odour and taste. Most significantly, this meat becomes unfit for human consumption (Domnguez *et al*., 2019).

To address issues of deterioration, natural chemicals from plants with antioxidant and antibacterial capabilities have been targeted as a way to enhance meat quality without compromising customer choice. Onion waste is common in the food business, and it necessitates a search for alternative uses for this waste (Benitez *et al*., 2011). By decaying, these wastes impact soil smell and, in certain situations, impair the environment (Bello *et al*., 2013). Onion's flavour characteristics also limit its use in animal diets (Benitez *et al*., 2011). However, one of the most common onion wastes, onion skin, is a rich source of quercetin and its derivatives (Swieca *et al.,* 2013). Quercetin a potent antioxidant also has antimicrobial, anti-inflammatory and anticarcinogenic properties (Swieca, *et al.,* 2013). According to reports, the inedible section of the onion has 77 times more quercetin than the edible portion (Ko *et al*., 2011). According to a research by Benitez *et al*. (2011), the onion skin contains primarily insoluble dietary fibre. It is claimed that dietary fiber-rich vegetal crops improve tissue quality, increase yield, and lower the cost of meat products (Guedes- Oliveira *et al*., 2016). Therefore, the goal of this study was to look into the physicochemical, microbial, and sensory properties of grilled chicken marinated in different onion skin solvent extractions.

Materials and methods

Experimental site

The experiment was carried out in the Animal Science Research Laboratory at the College of Animal Science, Joseph Sarwuan Tarka University, Makurdi, Benue State, Nigeria.

Extraction of the plant material

The OS was obtained from Wadata market in Makurdi, Benue State and sundried before milling. Water extraction was done by soaking 0.25kg of onion skin in a litre of distilled water (45°C) for 24 hr, it was then filtered using a sterile muslin cloth after which the extract was obtained and concentrated using water bath. For ethanol and methanol extraction, OS (0.25kg) was soaked in a litre of 80% of each solvent for 24hrs, it was then filtered using a sterile muslin cloth after which the extract was obtained and concentrated using water bath.

Preparation of grilled meat

Nine Abor Acre broiler birds (1.9±0.2 kg) live weight of 56 days' age were obtained from open market. The chickens were slaughtered, defeathered and the breast portion (250±50) were removed after which 3g of ethanol, methanol and water OS extract representing three treatments were added separately each to 1 liter of water in different clean container. Each treatment was replicated thrice. Each chicken breast was immersed in each container and stored at 4°C for 24 hours after which the meats were grilled in the oven at a temperature of 250°C for 30min. The grilled meats were stored at 4°C for six days.

Data collection

Extract yield: Extract yield was calculated using the formula below:

Weight of Extract / Initial weight of onion skin X 100

pH

The pH was measured using a digital pH meter model PHS- 25 Microfield instrument England according to the method described by AOAC (1998). The pH value of breast meat was determined by weighing 10g of sample into a blender with 90mL of distilled water and homogenized until smooth slurry was developed. The digital pH meter was placed in a buffer 6 solution in order to allow equilibrium for two minutes before placing it into prepared slurry and pH reading was taken.

Cooking Loss

Cooking loss was estimated in accordance with the method outlined by Mahendraker *et al*. (1998). Meat samples were weighed before grilling for 30 minutes. Cooked samples were allowed to cool then weighed. Cooking loss was calculated using:

$$\text{Cooking loss \%} = \frac{\text{weight of sample before grilling - weight of sample after grilling}}{\text{weight of sample before grilling}} \times 100$$

***Product yield*:** Product yield was calculated using the formula below:

Weight of grilled meat / weight of raw meat X 100

Microbial Evaluation

One gramme of the chicken meat was soaked and mixed with 9mL of distilled water. Serial 5-fold dilutions were performed in serial dilution tubes containing 9mL of distilled water. The 0.1mL from 10^{-3} and 10^{-5} was plated for the microbial load evaluation. Nutrient Agar was used to assess and monitor viable bacterial growth in the meat sample.

Sensory Evaluation:

The sensory evaluation of the samples was determined using a ten member panelists according to the procedures of AMSA (1995). The samples were evaluated using a 9-point hedonic scale for colour, flavour, juiciness, tenderness and overall acceptability.

Statistical analysis

Extract yield was analysed using descriptive analysis. Measurements of all other parameters were made in triplicate. Means of pH, cooking loss, cooking yield and sensory attributes were analysed using one-way ANOVA. Microbial evaluation was done using two-way ANOVA. Means of data found to be significantly different ($P<0.05$) were separated using Duncan Multiple Range Test of the same software. All statistical analyses were performed using the SPSS software (IBM Statistics version 22).

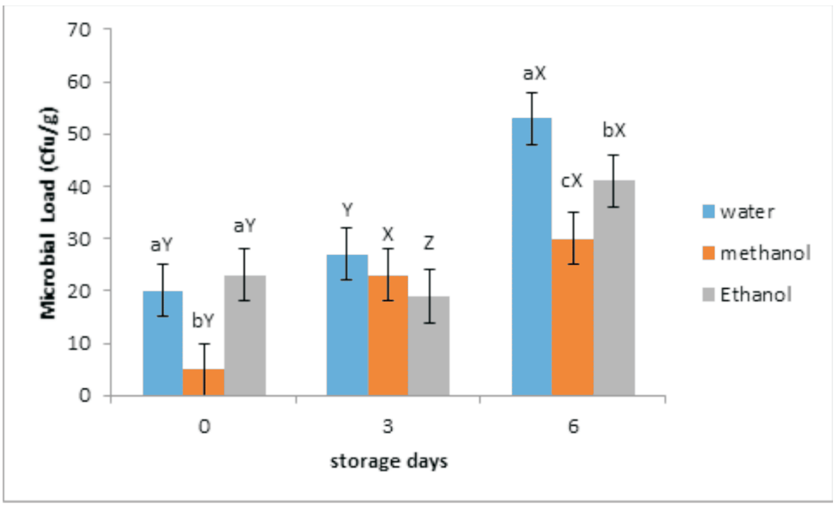

Figure 1: Effect of different solvent extraction of onion skin on microbial load of grilled chicken stored at 4°C for 6 days

Table 1: Effect of different solvent extraction of onion skin on yield and physicochemical properties of grilled chicken

		Extraction solvents			
Parameters	Water	Ethanol	Methanol	p-value	SEM
Extraction yield (%)	13.07^{a}	9.40^{b}	3.40^{c}	0.01	1.40
Cooking loss (%)	50.99^{a}	48.56^{ab}	45.06^{b}	0.04	1.06
Cooking yield (%)	49.01^{b}	51.44^{ab}	54.94^{a}	0.04	1.06
pH	6.27	6.23	6.33	0.69	0.04

^{ab} Means within a row with different superscripts differs significantly ($P < 0.05$); SEM: Standard Error of Mean;

Table 2: Effect of different solvent extraction of onion skin on sensory properties of grilled chicken

	Extraction solvents				
Parameters	Water	Ethanol	Methanol	p-value	SEM
Aroma	2.97	3.14	3.26	0.09	0.25
Flavour	3.24^{b}	3.15^{b}	4.43^{a}	0.04	0.14
Colour	6.01	6.14	5.98	0.21	0.24
Tenderness	4.46	4.67	4.32	0.23	0.13
Texture	4.45	4.56	4.34	0.16	0.17
Juiciness	5.56^{b}	5.24^{c}	6.35^{a}	0.04	0.11
Overall Acceptability	3.54^{b}	5.67^{a}	5.34^{a}	0.04	0.14

^{abc} Means within a row with different superscripts differs significantly (P < 0.05); SEM: Standard Error of Mean; T1-Water Onion skin Extract, T2-Ethanolic onion skin Extract, T3-Methanolic onion skin extract

Results and discussion

Figure 1 shows the effect of different solvent extraction of onion skin on microbial load of grilled chicken stored at 4°C for 6 days. On day 0, grilled meat marinated with OS methanolic extract was significantly lower than water and ethanolic OS extract while there was no significant different (P>0.05) among the solvent used on day 3. On Day 6, grilled meat marinated with methanolic OS extract was significantly lower than water and ethanolic extract while water extraction was the highest. There was no significant different (P>0.05) between microbial load of grilled chicken marinated with OS water extract on day 0 and 3 while day 6 was recorded highest. Methanolic extraction of OS notably reduced microbial load on day 0 while day 3 and 6 were not significantly different. The ethanolic extracted OS was recorded highest on day 6, followed by day 0 while day 3 recorded the least.

Microorganisms were detected in the products on the first day of storage. According to Sachindra *et al.* (2005), microorganisms could enter into meat products from other ingredients like spices, as well as from the environment, equipment and handlers during processing. This result also agrees with Lourenço *et al.* (2020), who reported microorganisms in meat product on the first day of production. Although, OS water extraction had the highest yield, methanolic extract significantly reduced the microbial load during the storage days. The balance in the microbial load on the third day of storage might be due the effect of phenolic compounds on the treatments. Also, the refrigerated storage condition might also have influence by inhibiting the growth of microbes.

The effect of different solvent extraction of onion skin on yield and physicochemical properties of grilled chicken is presented in table 1. Yield of OS from water was higher than methanol and ethanol. This finding agrees with Lee *et al*. (2014) who reported higher yield when water was compared to ethanolic extraction. This might be as a result of higher temperature used for the water extraction (Lee *et al*., 2014).The pH of grilled chicken was not significantly affected (p>0.05). However, cooking yield and cooking loss were influenced by different OS extraction. Cooking loss of grilled meat marinated with OS extracted with water (50.99%) was significantly higher than ethanolic (48.56%) and methanolic (45.06%) extraction. The meat yield from meat marinated with methanolic OS extraction (54.94%) was significantly higher than those extracted with ethanol (51.44%) while water extraction (49.01) recorded the least.

The higher cooking loss observed in meat marinated with OS water extraction might be due to high yield of the extract. Extract with high yield is expected to have higher content of antioxidative properties that can prevent cellular damage during meat processing. Cooking loss is a combination of liquid and soluble matter lost during cooking and with increasing temperature, water content decreases while fat and protein contents increase indicating that the main part of cooking loss is water (Brugiapaglia and Destefanis, 2012). During cooking, the various meat proteins denature and cause structural changes, such as the destruction of cell membranes, shrinkage of meat fibres and gel formation of myofibrillar and sarcoplasmic proteins (Jung *et al*., 2012; Tornberg, 2005). Onion skin extract can actively scavenge free radicals and thus prevent cellular damage (Sreelatha and Padma, 2009). Also, this result agrees with Shah *et al*. (2015) when *Moringa oleifera* leaf extract was used in beef product.

The sensory evaluation of grilled chicken marinated with different OS solvent extraction was presented in Table 2. Aroma, colour, tenderness and texture were not significantly affected ($P>0.05$). Flavour and juiciness of grilled chicken marinated with OS methanolic extraction were significantly higher ($P<0.05$) than Water and ethanolic extractions. Significant difference was not observed between flavour of grilled chicken marinated with OS water and ethanolic extraction while Juiciness of grilled chicken marinated with OS water extraction (5.56) was significantly higher than OS ethanolic extraction (5.24). The overall acceptability of grilled chicken marinated with ethanolic OS extraction and methnolic OS extraction were not significantly different ($P>0.05$) but higher than that of OS water extraction (3.54).

The significant ($P<0.05$) difference in Overall acceptability might be due to the significant effect of OS extract on tenderness, aroma and flavour which unarguably affect the preference of the consumers. This result agrees with that of Kurt and Ceylan, (2017) that reported significant ($P<0.05$) difference in overall acceptability when OS was used for chicken processing.

The non-significant difference ($P>0.05$) in tenderness and texture might be due to the same source of meat (chicken) and their collagen content, heat stability and myofibrillar structure of muscle (Muchenje *et al*. ,2009) that are all the same. This result disagrees with Kurt and Ceylan, (2007) that reported significant ($P<0.05$) difference in tenderness when onion skin extract was used for chicken processing. The grilled chicken colour was not influence by the OS Extracts. This could be due to addition of OS extract as an additive which may have little effect on the colour. Also, colour measured in this case is subjective which may not be accurate compared with the use of colorimeter. This result disagrees with the result of Kurt and Ceylan, (2007) that reported significant ($P<0.05$) different in colour when OS extract was used for chicken processing.

The non-significant ($P>0.05$) difference in aroma is might be due to the application of OS extract as an additives and the same processing method i.e. grilling was used. This result disagree with the result of Kurt and Ceylan, (2007) that reported significant ($P<0.05$) difference in aroma when onion skin extract was used for chicken processing.

Conclusion

This study demonstrated that solvent used to extract onion skin influence the yield of the extract. Marination of chicken with onion skin methanolic extraction decreased microbial load during the days of storage at 4^{o} C. Physicochemical properties of grilled chicken improved with marination with onion skin methnolic extract before grilling. Chicken marinated with methanolic and ethanolic onion skin extract prior to grilling were more preferred.

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