

Aromatic amines and sensory evaluation of fish grilled on different types of wood

الأمينات العطرية والتقييم الحسي للأسماك المشوية علي انواع الخشب المختلفة

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Abstract

The aim of this study is to improve the flavors of tilapia fish by grilling on smoked wood chips. It is prepared from fresh tilapia fish , with the addition of some healthy spices to it, and comparing the control sample with the samples that were grilled on smoked (rose, oak and acacia) wood chips. The neutralization of the retention time of amine acids in tilapia fish was also verified by grilling on smoked wood chips, as well as determining the statistical analytical values of amines acids in grilling tilapia fish on smoked wood chips. The results obtained indicate that the sample of tilapia fish grilled on rosewood chips had a higher amine acids retention time compared to other samples. The retention time of amino acids in the sample of tilapia fish grilled on rosewood chips was 315.59% and in the samples that were grilled on oak and acacia wood chips, it was 165.13 and 122.47%, respectively. The tilapia fish grilled on rosewood chips had a higher percentage of amines acids in tilapia fish grilling (23.06%) than samples grilled on oak and acacia wood chips (11.21% and 6.04% respectively. The results also indicated that there were statistically significant differences in sensory evaluation between the tilapia fish sample grilled on (rose ,oak and acacia) wood chips. (acacia and rose) wood chips recording 45.14% and 45% respectively, while the control sample had the lowest (35.3%).

Key Words:

Grilling, Tilapia fish, Oak wood,Acacia wood, Rose wood

Amines acids.

Introduction

The diet can be defined as a diverse, balanced, and healthy food based on individual characteristics (age, gender, lifestyle and physical activity), cultural context, locally available foods, and dietary habits. Healthy nutrition is defined as an individual's intake of foods containing sufficient quantities of nutrients that are important for natural growth and optimal mental development in patients, healthy health, maintaining good health during human life (Te Morenga *et al.*, ٢٠١٤).

Nutrients are the substances that nourish the body. Nutrients can be divided into micro-macronutrients, which both are vital for good health. Macronutrients such as proteins, lipids, and carbohydrates (Lilly *et al.*, ٢٠١٧). Micronutrients such as vitamins and minerals are essential dietary elements that are essential in very small quantities, they must be supplied from outside sources to the body (Mohanty, ٢٠١٥).

As fish, poultry, meat are excellent sources of proteins, amino acids, fats and mineral salts (such as zinc, iron, and phosphorus), as well as vegetables for their vitamins, fibers, and other nutrients (Dos Reis *et al.*, ٢٠٢٢).

Fish as a food has been playing a key role in providing the nutrient to many animals as well as humans. Tilapia fish is a good source of food but also has high nutritional value which improves health. Fish consumption in daily basis also has its role in the prevention of heart diseases! (Chrysohoou *et al.*, ٢٠٠٧).

Fish provides essential nutrients, especially proteins of high biological value and fats, so it is often referred to as 'rich food for poor people'. Protein and fats are the major nutrients of fish, which determine the nutritional value of fish (Lilly *et al.*, ٢٠١٧). Fish is a food with excellent nutritive value, that provides high quality protein and a large variety of vitamins and minerals, vitamin A & D, magnesium and phosphorus. The micro and macronutrients present in fish make it better than other animal protein sources. Apart from being a food source, fish also functions to prevent human beings from a variety of diseases in the world. Fish contains ١٥-٢٠% protein of its overall live body weight. The fish protein contains the essential amino acids which improve the overall nutritional quality of a mixed diet (Mohanty, ٢٠١٥).

A portion of ١٤٠ gm of fish can provide about ٥٠-٦٠% of the daily protein required by an adult human. Fish is also rich in micronutrients which tend to be more easily available than those from plant foods. As compared to land living animals, fish are a rich source of protein and have a high content of omega-٣ long chain polyunsaturated fatty acids (Balami *et al.*, ٢٠١٩).

Most people use diverse cooking methods, and there are many ways to cook meat, including: boiling, grilling, pan-frying, stir-frying and roasting which is done to excess meat flavor, taste, palatability and to turn it tender (Omojola *et al.*, ٢٠١٥). Since cooking affects the nutritional values of these important elements, care must be taken when choosing the cooking methods and pots used to cook these nutrients to retain their nutritional value for better health in order to avoid any health risks resulting from their poor cooking. The cooking experiments showed that heat treatment had diverse effects on the different nutrients (Gerber, ٢٠٠٧)

Grilling is a form of cooking that involves heat applied to the surface of food, commonly from above, below or from the side. Grilling usually involves a significant amount of direct, radiant heat, and tends to be used for cooking meat and vegetables quickly. Heat transfer to the food when using a grill is primarily through thermal radiation. Heat transfer when using a grill pan or griddle is by direct conduction. Direct heat grilling can expose food to temperatures often in excess of ٢٦٠ °C (٥٠٠ °F). Grilled meat acquires a distinctive roast aroma and flavor from a chemical process called the Maillard reaction. The Maillard reaction only occurs when foods reach temperatures in excess of ١٥٥ °C (٣١٠ °F) (Schröder, ٢٠٠٣). Throughout history, barbecue has occupied a special place in most cultures. Charcoal grills are becoming progressively popular in restaurants, snack bars and other eateries across many countries. Despite its popularity, barbecuing, and in particular charcoal grilling, is a huge source of outdoor air pollution. In addition to the dangers of ingesting chemicals on grilled food, the inhalation of smoke or absorption through the skin is also a health risk (Wu *et al.* , ٢٠١٥)

Barbecue smoke contains a wide range of compounds, including polycyclic aromatic hydrocarbons (PAHs), which are carcinogenic and easily absorbed in the lungs. It has been demonstrated that the particle-bound organic compounds emitted from charbroiled meat cooking operations can induce oxidative stress and inflammatory responses in human bronchial epithelial cells. These responses and their potential mechanisms were found to be quite similar to those resulting from traffic-derived emissions

(Li *et al.*, ٢٠١٤). Molecular and biochemical studies have shown that exposure to cooking fumes may lead to lung cancer by generation of reactive oxygen species, gene damage, inhibition of proteins involved in cell survival and proliferation, among other mechanisms (Wang *et al.*, ٢٠١٧)

Studies have shown that cooking beef, poultry, and fish at high temperatures can lead to the formation of heterocyclic amines, benzopyrenes, and polycyclic aromatic hydrocarbons, which are carcinogens (Sugimura *et al.*, ٢٠٠٤).

According to the Hearth, Patio and Barbecue Association in the United States (HPBA), wood pellet grilling is one of the hottest trends in the grilling industry. For the last several years, the vast majority of wood pellets was produced for industrial and residential heating, but in recent years consumers can also purchase wood pellets (BBQ pellets) that are marketed specifically for grilling. Rising wood pellet production and grill sales are a response to a novel cooking option-wood pellet grilling-that has the versatility and benefits of a convection oven, from grilling to smoking, roasting, and even baking Jautaikis, (٢٠١٦) , Raichlen, (٢٠١٩) and PitBoss ,(٢٠٢٠).

In recent times wood has appeared perhaps as the safest material in the kitchen, as it does not react with unhealthy acid reactions such as metal pots, or releases chemicals such as plastic when it comes into contact with hot dishes, as well as it does not melt like plastic, and does not heat up the temperature like metal. Wood is divided into natural timber, artificial timber and natural timber, including local timber such as olive, fusion, berries, etc.) (Mazzeo *et al.*, ٢٠١١).Therefore, the research aims to find a healthy way to grill fish using different types of wood.

Materials and Methods

Materials

-Tilapia fish, salt, dried coriander, garlic, black coal, vinegar and water. Purchased from local market in Assiut.

- Imported woods(rose and oak) were purchased from stores selling imported wood in Egypt (Awlad Wanis wood trading stores in Tanta)

-Local wood (acacia)was purchased from local wood stores in Assiut(Al-Ghanam stores for local wood trading in Mahalla al-Kubra)

First preparing wood samples

The first wood samples were cut into an area of ٢٨ cm x ١٦ cm, the oak wood was cut into an area of ٢٤ cm x ٢٠ cm, and the acacia wood was cut into an area of ٢٠ cm x ٢٠ cm. Then sand the wood pieces from both sides and clean them with sandpaper.

Preparing wood chips

Then prepare the wood chips immediately before the grilling stage by submerging them completely in water for half an hour, then removing them from the water and filtering them from the water.

Then begin the steps and stages of grilling on them by placing them on the grill until the wooden board is heated before placing the samples on it and starting the grilling process.

Second : Preparing of samples and grilling conditions

١- Grilled tilapia fish

Total samples of tilapia fish were four samples of tilapia fish

The first sample was grilled using coal.

Second sample was grilled using rosewood, the third sample was grilled using acacia wood, and the fourth sample was grilled using oak wood.

These samples were similar in size and weight, but different in the type of wood used for grilling.

Preparing tilapia fish for grilling

Samples of tilapia fish that weighed ٢٥٠ grams. It was washed and cleaned well and soaked in flour, lemon and salt for ١٥ minutes, then washed well with water.

It is seasoned with ٥ grams of (salt, coriander, cumin, ٥ milliliters of lemon and left in the seasoning for ١٥ minutes until the seasoning is absorbed.

The control sample is grilled using coal. The second sample is grilled using rosewood, the third sample uses acacia wood, and the fourth sample uses oak wood. The tilapia fish samples are grilled at a temperature of ٢٠٠°C.

Without adding any greasy substance to the surface of the grill tilapia fish is turned over to the other side after ٨ minutes. After it is fully cooked, the tilapia fish is removed from the grill and placed in a stainless steel container until it cools completely.

The cooking time differed depending on the type of wood used. The tilapia fish sample that was grilled with rosewood took ٣٢ minutes, while the sample prepared using acacia wood took ٢٣ minutes, and the sample prepared using oak wood took ٢٩ minutes.

The tilapia fish is turned over to the other side after ٨ minutes. After it is fully cooked, the tilapia fish is removed from the grill and placed in a stainless steel container until it cools completely. Then it is transferred to foil dishes, wrapped in plastic bags, and preserved. In the refrigerator until the next morning to perform the determination of aromatic hydrocarbons and the determination of aromatic amines in the laboratory.

Products yield

The weight of tilapia fish was recorded before and after cooking and the yield was expressed as a percentage

product yield = weight of cooked tilapia fish X 100

Analysis of aromatic amines in tilapia fish

Tissue cutting to small size. Approximately 5 g of sample was weighted and 20 ml of n-Hexane Sonicate was added for 30 min, with draw the clear organic filtered through anhydrous sodium sulfate then centrifugation at 10,000 rpm for 5 min at 25 °C, Take the bottom Clear layer, then injected it on the GC/MS (Wendy, 2015).

Yield factor of grilling tilapia fish on smoked wood chips

The calculated food productivity was calculated from the cooked ratio and the results were expressed in the number of servings of 250 grams of grilling tilapia fish on smoked wood chips (Wendy , 2015).

Sensory evaluation of grilling tilapia fish on smoked wood chips

Grilling tilapia fish on smoked wood chips was evaluated in terms of (color, taste, flavor, texture and appearance). All these attributes were evaluated by 50 persons (30 specialists in nutrition and food science) and 20 ordinary consumers on a hedonic scale ranging from 1 to 10 (1 is very bad and 10 for excellent) according to. (1 =dislike extremely, 2= dislike very much, 3= dislike moderately, 4 = dislike slightly, 5 = neither like a nor dislike, 6 = like slightly, 7 = like moderately, 8 = like very much and 9 = like extremely) according to (Konieczny *et al.*, 2007) Scores were collated and analyzed statistically.

Data were presented as the mean of duplicate± standard deviation (mean ± SD). A test was used to establish the significance of differences among mean values at (p< 0.05). Analysis of variance (ANOVA) was carried out using Proc Mixed of SAS package version 9.2 (SAS, 2008) and means were compared by the Duncan test at a 5% level of significance (Steel and Torrie 1981).

Results and Discussion:

The results in Table (1) and Figure (1) showed that the statistical analytical values of amines acids in grilled tilapia fish on smoked wood chips. There were statistically significant differences at ($p < 0.05$) between the values of biogenic amines acids in grilling tilapia fish samples on smoked wood chips, as the control sample recorded a value of $15,376$ mg/kg. These results were consistent with (Waleed *et al.*, 2021) They found that values of amines acids in Tilapia ($17,700\% \pm 0,506$ mg/kg). While the values of biogenic amines acids for the grilling tilapia fish samples on smoked wood chips (Oak and Acacia) were ($11,211$ mg/kg and $6,04211$ mg/kg respectively). The levels of biogenic amines acids were low or moderate in all grilling tilapia fish samples on smoked wood chips tested in this study. These results were in agreement with (Esraa *et al.*, 2024) the analysis revealed that mean values of concentrations (mg/100g) were $233,2 \pm 20,0$ in raw frozen tilapia fish and $186,8 \pm 10,7$ in grilled tilapia fish.

There were highly statistically significant differences at ($p < 0.01$) in the values of amines acids the grilling tilapia fish sample on smoked rosewood chips and recorded $23,020$. Rabie *et al.*, (2014) We can attribute this to the aseptic role of smoke, which inhibits the growth of amine- decarboxylating bacteria. These results are in agreement with Esraa *et al.*, (2024) They found that these amines acids serve as critical biomarkers for evaluating food quality and safety. Their physiological implications for human health necessitate vigilant monitoring particularly in tilapia fish, where elevated concentrations can cause histamine acids poisoning and toxicity.

The highest percentage of amines acids was recorded in a grilling tilapia fish sample on smoked rosewood chips $310,09$ With a significant difference at ($P < 0.01$). These results are consistent with Abuhlega and Ali, (2022) they found that the toxic level of amines acids is difficult to determine, due to their specific characteristics, as well as their concomitant presence with other amines acids. However, a maximum allowable level of total amines acids has been suggested at $700-900$ mg/ kg body weight.

Table(1)Effect of amines acids in grilling tilapia fish on smoked wood chips

Samples	Types of wood			
	Control	Rose	Acacia	Oak
Amines Value mg/kg	15,37 ± 1,00	23,05 ± 1,00	6,04 ± 1,00	11,21 ± 1,00
P. Value	*	**	*	*

Values are mean ± standard deviation. Means in the same column are significantly different ($p < 0,05$) and highly significantly ($p < 0,01$).

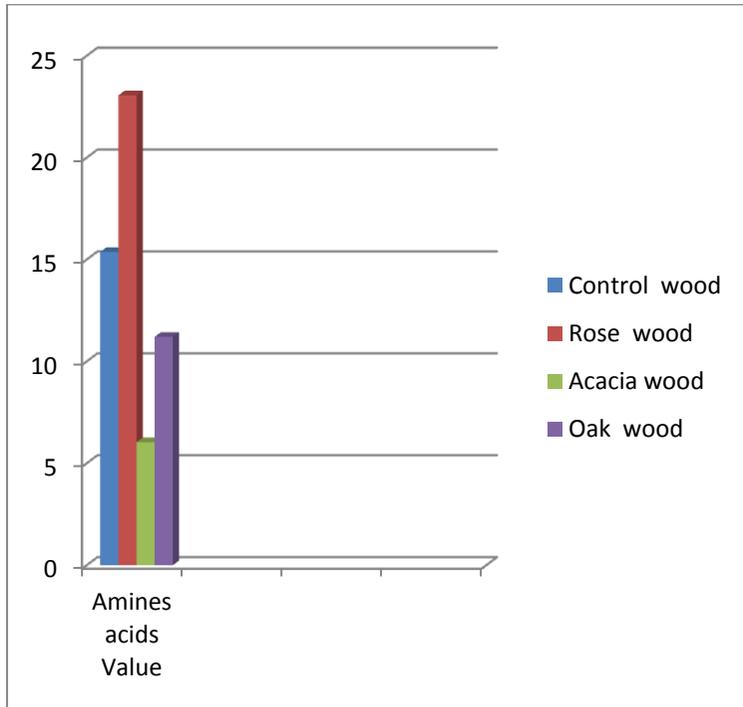


Fig. (١): Effect of amines acids in grilling tilapia fish on smoked wood chips

Table (٢) and Figure (٢) revealed that the retention time of amines acids in samples of tilapia fish grilling on smoked wood chips the control sample had (١٣٢,٣٣) However, grilled tilapia fish samples on smoked wood chips (Acacia and Oak) which were (١٢٢,٤٧, ١٦٥,١٢) respectively. It showed that there were significant differences at ($P < ٠,٠٥$) between grilling tilapia fish samples on smoked wood chips (Acacia and Oak). The derivatives of tryptamine and phenethylamine were detected at a retention time of ١٣ and ١٥ min; respectively, under UV irradiation (Kishikawa *et al* ٢٠٢٣).

Table (٢): Retention time of amines acids in tilapia fish through grilling on smoked wood chips

Samples	Retention Time/ min			
	Control	Rose wood	Acacia wood	Oak wood
Amines	١٣٢,٣٣ ± ١,٠٠	٣١٥,٥٨ ± ١,٠٠	١٢٢,٤٧ ± ١,٠٠	١٦٥,١٢ ± ١,٠٠
P. Value	*	**	*	*

Values are mean ± standard deviation. Means in the same column are significantly different at ($p < 0,05$) and highly significantly at ($p < 0,01$).

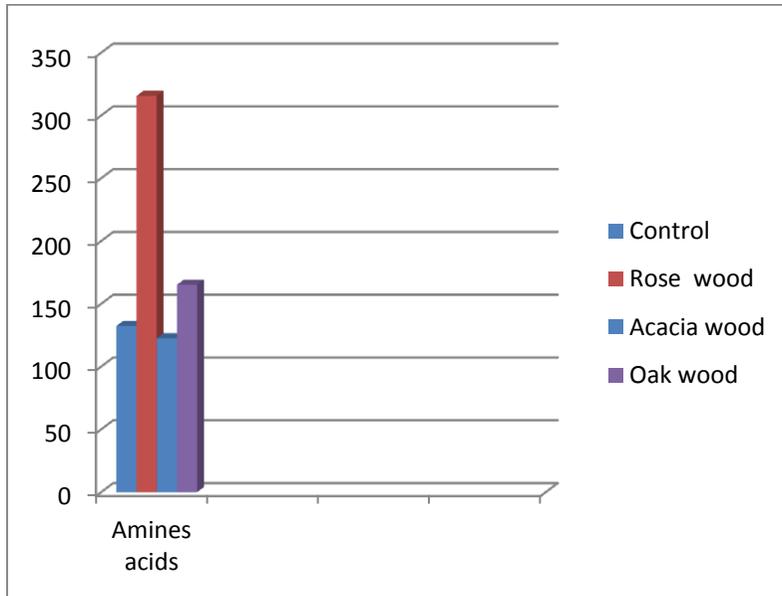


Fig. (٢): Retention time of amines acids in tilapia fish through grilling on smoked wood chips

Table (٣) and Fig (٣) showed the yield factor of grilling tilapia fish on smoked wood chips. The results revealed that the highest yield factor in the Oka wood chips (٠,٩), the number of tilapia fish was ١ piece and the weight of the piece was ٢٢٥ grams. While the Acacia wood chips (٢١٠) and Rose wood chips (٢١٠) were the yield factors compared in Acacia wood chips and Rose wood chips (٠,٨٤). While Control simple (١٦٠mg) was the lowest in productivity factor ٠,٦٤ where the number of servings was ١ piece. These results were in agreement with that reported by Wendy, (٢٠١٥) Some meats cannot be accurately portioned until they are cooked. This applies particularly to roasts, which shrink during cooking. The amount lost due to shrinkage can be minimized by incorporating the principles of low-temperature roasting, but some shrinkage is unavoidable. The cooking loss test serves the same function as the meat cutting yield test.

Table(٣): Yield factor of grilling tilapia fish on smoked wood chips

Description	Control	Rose wood	Acacia Wood	Oak wood
Raw material (mg)	٢٥٠	٢٥٠	٢٥٠	٢٥٠
Tilapia fish Grilled (mg)	١٦٠	٢١٠	٢١٠	٢٢٥
Yield factor	٠,٦٤	٠,٨٤	٠,٨٤	٠,٩
Number of Tilapia fish	١	١	١	١

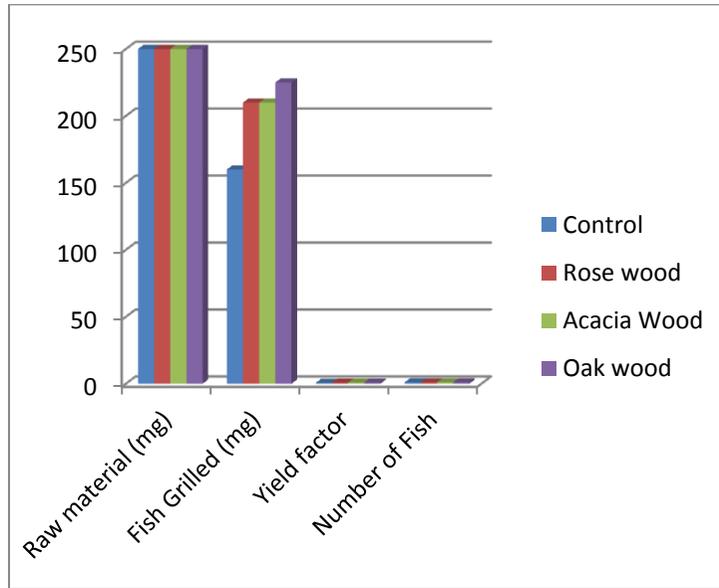


Fig. (٣): Yield factor of grilling tilapia fish on smoked wood chips

Table (٤) and Fig.(٤): showed the sensory evaluation for grilling tilapia fish simples on smoked wood chips. There was a significant difference at ($P < 0,05$) between tilapia fish grilling on smoked wood chips (Rose, Acacia and Oak)in appearance, texture, color, taste, flavor and overall acceptability. The best overall acceptability was that of grilling tilapia fish on smoked wood chips (Acacia and Rose) ٤٥,١٤%, ٤٥%; respectively, where grilling tilapia fish on smoked Oka wood chips recorded ٤٤,١٦% and control

simples recorded ٣٥%. Record the best color in grilling tilapia fish on smoked wood chips (Rose and Acacia) (٩,٥٦ and ٩,٠٨; respectively),while the control sample recorded ٦,٤. Grilling tilapia fish on smoked rosewood chips had the best flavor ٩,٥٨, followed by oak and acacia (٨,٨٤ and ٨,٨ respectively), while the control sample recorded ٦,٠٦. These results were in agreement with that reported by Schrader, (٢٠٢٣) all the other descriptors were in accordance with the flavor wheel for sensory analysis of fish raised in RAS. The odor qualities of the detected odorants correlated very well with the attributes reported by the panelists during the descriptive aroma profile analysis (Rodrigues et al., ٢٠٢٤).

Table (٤): Sensory evaluation for tilapia fish Samples grilled on smoked wood chips

Samples	sensory evaluation					
	Appearance (١٠)	Texture (١٠)	Color (١٠)	Taste (١٠)	Flavor (١٠)	Overall acceptability (٥٠)
Control	٧,٨٤ ± ١,٠	٨,٩٤ ± ١,٠	٦,٤ ± ١,٠	٦,٠٦ ± ١,٠	٦,٠٦ ± ١,٠	٣٥,٣ ± ١,٠
Rose wood	٨,٧٢ ± ١,٠	٨,٤٦ ± ١,٠	٩,٥٦ ± ١,٠	٨,٦٨ ± ١,٠	٩,٥٨ ± ٠,٥٧٧	٤٥ ± ١,٠
Acacia wood	٨,٧٦ ± ١,٠	٩,٢٨ ± ١,٠	٩,٠٨ ± ١,٠	٩,٢٢ ± ١,٠	٨,٨ ± ١,٠	٤٥,١٤ ± ١,٢٥٨
Oak wood	٨,٩ ± ١,٠	٨,٠٢ ± ١,٠	٨,٧٤ ± ١,٠	٩,٦٦ ± ١,٠	٨,٨٤ ± ١,٠	٤٤,١٦ ± ١,٠
p.value	*	*	*	*	*	*

Values are mean ± standard deviation. Means in the same column are significantly different ($p < 0,05$)

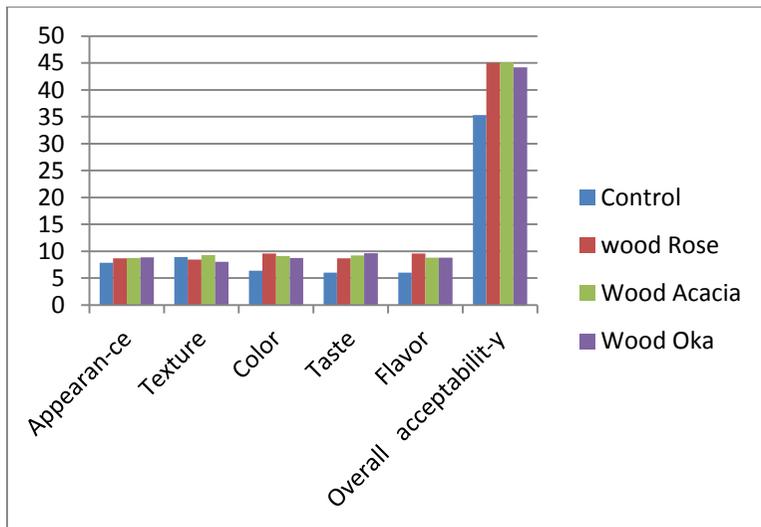


Fig. (٤): Sensory evaluation for tilapia fish grilled on smoked wood chips

Conclusion

The results of neutralization of amino acid retention time in tilapia fish by grilling on smoked wood chips (rosewood, oak and acacia) showed that the tilapia sample grilled on rosewood chips had a higher amino acid retention time compared to other samples, as the amino acid retention time in the tilapia sample grilled on rosewood chips reached 315,586%, and in the samples grilled on oak and acacia chips it was 165,125 and 122,471% respectively, as well as determining the statistical analytical values of amino acids in grilling tilapia fish on smoked wood chips. The results of the study showed that the percentage of amino acids in the tilapia samples grilled on rosewood chips was higher (23,059%) than the samples grilled on oak and acacia chips (11,211 and 6,04211% respectively). The results also indicated that there were statistically significant differences in the sensory evaluation between grilled tilapia samples on wood chips (rosewood, acacia and acacia). Rosewood chips recorded the highest percentage because it gives a better color compared to the study samples.

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الأمينات العطرية والتقييم الحسي للأسماك المشوية علي انواع الخشب المختلفة

مستخلص البحث:

هدفت هذه الدراسة إلى تحسين نكهات الأسماك المشوية على رقائق الخشب المدخنة، حيث تم تحضيرها من الأسماك الطازجة مع إضافة بعض التوابل الصحية إليها، ومقارنة عينة التحكم مع العينات التي تم شوائها على رقائق الخشب المدخن (الورد والبلوط والسنت). كما تم التحقق من تحديد زمن احتباس الأحماض الأمينية في الأسماك بالشواء على رقائق الخشب المدخن، وكذلك تحديد القيم التحليلية الإحصائية للأحماض الأمينية في شواء الأسماك على رقائق الخشب المدخن. وتشير النتائج التي تم الحصول عليها إلى أن عينة الأسماك المشوية على رقائق خشب الورد كانت الأعلى في زمن احتباس الأحماض الأمينية مقارنة بالعينات الأخرى. بلغ زمن احتباس الأحماض الأمينية في عينة الأسماك المشوية على رقائق خشب الورد %١٥,٥٨ في العينات التي تم شوائها على رقائق خشب البلوط والسنت كانت %١٦٥,١٢٥ و %١٢٢,٤٧١ على التوالي. أظهرت الأسماك المشوية على رقائق خشب الورد قيماً تحليلية إحصائية أعلى للأحماض الأمينية في شواء الأسماك (٢٣,٠٥٩%) من العينات المشوية على رقائق خشب البلوط والسنت (١١,٢١١) و %٦,٠٤٢١١ على التوالي). وأشارت النتائج أيضاً إلى وجود فروق ذات دلالة إحصائية في التقييم الحسي بين عينات الأسماك المشوية على رقائق خشب (الورد والسنت والبلوط) وعينه الكنترول ولاقت القبول الأفضل عينه السمك المشوي على رقائق خشب (السنت والورد) وسجلت %٥,١٤ و %٤٥ على التوالي وكانت عينه الكنترول الاقل %٣٥,٣ .

الكلمات المفتاحية:

الشواء، أسماك البلطي، خشب (البلوط والسنت والورد)، الأحماض الأمينية.