Available online at www.elixirpublishers.com (Elixir International Journal)

Aquaculture

Elixir Aquaculture 97 (2016) 42020-42024

ISSN: 2229-712X

Sensory Analysis of Oil from Nile Tilapia, *Oreochromis Niloticus*, as Potential Food Oil

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ARTICLE INFO

Article history:

Received: 21 April 2015;

Received in revised form:

27 July 2016;

Accepted: 2 August 2016;

Keywords

Tilapia oil,

Colour,

Odour,

Texture.

ABSTRACT

Fats from guttered Nile tilapia were collected, melted into oil and used to fry; eggs, beef sausages and beef. Widely used oils such as vegetable oil and sunflower oils were use as control oils. Ten (10) semi trained panellist judged the test oils used in frying the foods based of the attributes of colour, odour, flavour, texture and overall acceptability using 3 descriptions: "like", "neutral" and "dislike" The results shows that Tilapia oil can compete favourable with other commercial oil, hence it's extraction and use be promoted.

Introduction

Aquaculture has been the fastest growing sector of animal food production in the world since 1970. Due to stagnating wild fisheries and a growing human population, aquaculture is expected to fill the gap in supplies of fish as food for humans, as demand continues to increase [6].

The consumption of fish is widespread because of it's rich nutritional content. For example, fish is low in saturated fats, carbohydrates, cholesterol and provides not only high-value protein but also a wide range of essential micronutrients, including various vitamins, minerals, and polyunsaturated omega-3 fatty acids. Thus, even in small quantities, provision of fish can be effective in addressing food and nutritional security among the poor and vulnerable populations around the globe. Consumption of fish oils prevents cardiovascular disease and other diseases in the dementia family. Fish oil occurs either as a by-product of fishery or is produced specifically from industrial fish or from fish waste. The steeply rising demand for fish oil as a food supplement has now boosted the specific production of fish oil worldwide. For instance, fish oil production for commercial and subsistence use of herrings and Cod among others have gained popularity and recognition in some parts of the world.

In Ghana and many other countries in the West African Sub-region, the Nile Tilapia, *Oreochromis niloticus* is the most widely cultured fish. Fish caught from the wild or harvested from farms are guttered and the visceral mass removed and discarded indiscriminately n some instances are thrown back into the water where it came from. Often, this creates unsightly scenes and offensive odours. However, these by-products can be put into good use in ways that can; increase the income generated from fish production as well as maintaining a clean and healthy environment. .

In recent times, people consuming animal and plant products other than fish products generally tend to reject or try to avoid products that contained excessive fats and oil perhaps of fear of obesity or contracting cardiovascular diseases. In the light of the above, the study was conducted to access the acceptability of Tilapia oil when used to prepare food with the aim of reducing the waste generated from fish production -as well as placing value on the supposedly discarded waste (fats).

Materials and Methods

Sample collection

Fat from farm raised *Oreochromis niloticus* were acquired from Adom Blackie farms in the Eastern Region of Ghana during harvesting and two market brand oil, vegetable oil (Frytol) and sunflower oil were bought from the tamale market together with two (2) pound of beef, one create of poultry eggs and three (3) packets of beef sausages (30 pieces).

Oil extraction

Fat from the fish was obtained by gathering visceral from guttered fish by market women who bought fish harvested from the farm. The fat was separated from the internal organs and soaked in physiological solution to disinfect it. Fat was then heated in a saucepan to melt for about five minutes, allowed to cool and for solid particles to settle at the bottom, this facilitated decantation. The product obtained, referred to as Tilapia oil was then stored in bottles until use. Commercially sold - vegetable and sunflower oil from were purchased from the open market for use as control oil

Food sample preparation

Foods that were used in the experiment are egg, beef and beef sausage. These food items were selected because they are widely available and consumed by many people . A crate of eggs, consisting of 30 pieces was bought and broken into one bowl, salted to taste. Equal quantities were then fried with inthree different saucepans containing each oil type. For the beef sausage, 30 pieces each of 30 g were steamed with salt and ginger for five minutes. From these steamed sausage, 10 pieces were fried using three different saucepans for each of the test oils. Equally, 30 pieces of beef (each of 30 g) was steamed together for twelve (12) minutes with salt and ginger and 10 pieces fried for five (5) minutes using each test oil.

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Sample coding

Alphabetical codes where given to the oil samples whereas each food item where given numerical codes attached to the respective alphabetical codes of oil used.

Panellist for sensory evaluation

Ten (10) panellists ranging between the ages of 19 to 24 years (comprising both sexes) from each of the following; Faculty of Agriculture, Faculty of Renewable Natural Resources Faculty of Agricultural Business and Communication Studies, Food Processing and Technology Unit all from the University for Development Studies in the Nyankpala campus were selected for the study. The panelists were selected based on their ability to distinguish various attributes (colour, taste/flavour, odour, tenderness and overall acceptability), interest and availability. The panellist were tasked to rate foods prepared using various oils based on the afore mentioned attributes using a 3 point hedonic scale. The description was: like, neutral and dislike.

Statistical analysis

The data was analyzed using statistical package for social sciences (SPSS) version 16. Results were computed using simple descriptive statistics and presented using tables and graphs. Analysis of variance was used to check for significant difference among results.

Results

Colour

In Figure 1, like rating for egg was highest when it was fried with vegetable oil (9 points) and was least for sunflower oil (8 points) and Tilapia oil (8 points). Sausage fried with various test oils was in the order, sunflower oil (7 points) > Tilapia oil (6 points) > vegetable oil (4 point). Beef fried with vegetable oil and sunflower oil were liked most (9 points) as they both had the same rating and was liked least (7 points) when fried with Tilapia oil.

In terms of neutrality, the panellist rated egg when fried with sunflower oil as 2 points, and that of vegetable oil as 1 point and Tilapia oil as 1 point. Sausage fried with vegetable oil scored 5 points with sunflower oil scoring 3 points and Tilapia oil scoring 2 points. Beef fried with Tilapia oil had 2 points; vegetable oil had 1 point and sunflower oil 1 point.

Among panellist who disliked the influence of the oils on the colour of the food items, zero records for eggs, sausage and beef indicate no dislike for use of sunflower oil.

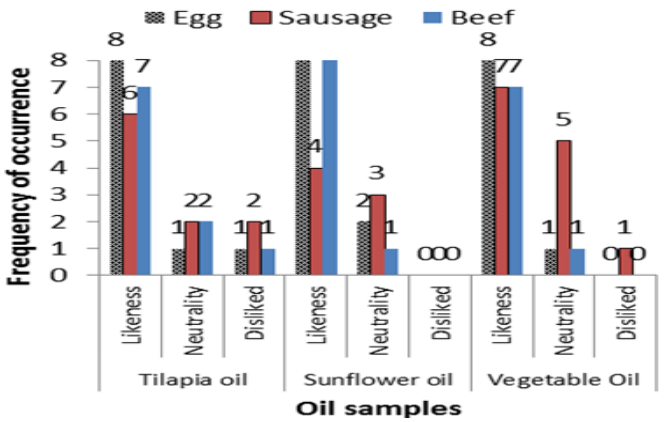

Figure 1. Rating for colour

Odour/Smell

Assessing the likeness of odour for the eggs fried with all-three oils, shows equal ratings of 8 points each. For sausage, same ratings of 5 points were recorded for vegetable and Tilapia oil and higher rating for sunflower oil (7 points). Beef scored highest when fried with vegetable (9 points) and sunflower (9 points) oils and least with Tilapia (6 points) oil.

In figure 2, expressing for neutral thoughts in terms of the influence of oils on the odour of all three-food items implies that, vegetable oil, scored the highest score of 2 + 5 + 1 = 8 for eggs, sausage and beef respectively. The least score recorded was for sunflower oil with a score of 2 + 3 + 1 = 6 for eggs, sausage and beef respectively.

From the figure 2, no scores were recorded for dislikeness of the influence of the test oils on the odours of food items when fried with vegetable and sunflower oils

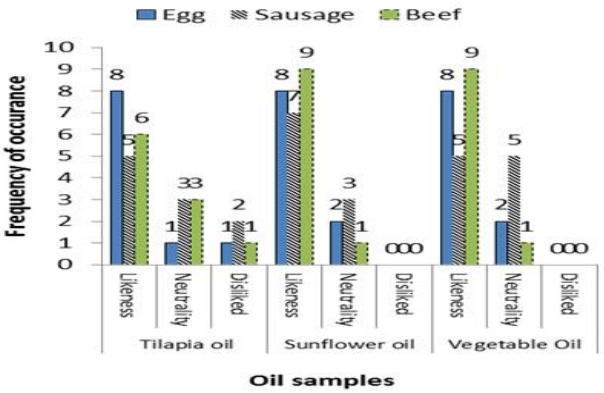

Figure 2. Rating for odour

Flavour/taste

The flavour/taste of egg fried with sunflower oil (9 points) was liked highest by the panellist and least when fried with vegetable oil (6 points). Tilapia oil (6 points) was rated highest and vegetable oil (3 points) scoring least when they were used in frying sausage, while the flavour of beef fried with the sunflower (9 points) oil was rated highest and that vegetable (7 points) oil scored least.

The ratings of panellist that were neutral showed that egg was rated highest with vegetable oil (3 points) and least with sunflower oil (1 point). In frying of sausage that of vegetable oil (5 points) and sunflower oil (5 points) were rated highest and tilapia oil (3 points) was rated least. Beef fried with vegetable oil (3 points) was highest while least scores form the panellist was that of sunflower (1 point) and Tilapia (1 point) oils.

Panellist that dislike the flavour/taste of egg, sausage and beef when fried with the oil sample showed that, egg fried with sunflower (1 point) and Tilapia (1 point) oil was disliked most and was not disliked when fried with and sunflower oil. Sausage fried with vegetable oil (2 points) was disliked most while least of the panellists disliked when it was fried with Tilapia oil (1 point) and only beef that was fried with tilapia oil was disliked indicating that egg, sausage and beef fried with sunflower and vegetable oil scored zero ratings.

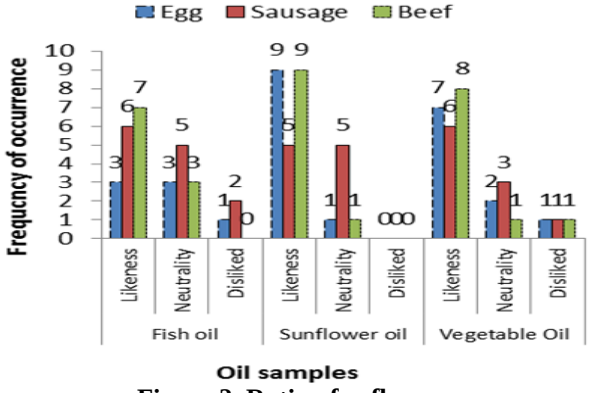

Figure 2. Rating for flavour

Table 1. Analysis of variance for Like rating

Sensory Attribute	Like rating(mean ± standard error)			S- value
	Sunflower oil	Tilapia oil	Vegetable oil	
Colour	8.00 ± 0.58	6.33 ± 0.88	7.33 ± 1.20	0.804
Odour	8.00 ± 0.58	7.00 ± 0.58	7.33 ± 1.20	0.482
Flavour	7.67 ± 1.33	7.00 ± 0.58	5.00 ± 1.00	0.236
Tenderness	7.00 ± 0.58	6.00 ± 0.58	7.67 ± 0.88	0.304
Overall acceptability	8.33 ± 0.33	7.33 ± 1.20	7.66 ± 0.46	0.729

Table 2. Analysis of variance for neutral rating

Sensory Attribute	Neutral rating(mean ± standard error)			S- value
	Sunflower oil	Tilapia oil	Vegetable oil	
Colour	2.00 ± 0.58	2.33 ±0.67	2.66± 1.20	0.864
Odour	2.00 ± 0.58	1.67±0.33	2.33 ± 1.33	0.864
Flavour	2.33 ± 1.33	2.00± 0.58	3.67 ± 0.67	0.451
Tenderness	2.33 ± 0.67	3.00± 0.58	1.67 ± 0.37	0.394
Overall acceptability	1.67 ± 0.33	1.67± 1.20	1.67 ± 0.67	1.000

Table 3. Analysis of variance for dislike rating

Sensory Attribute	Dislike rating (mean ± standard error)			S- value
	Sunflower oil	Tilapia oil	Vegetable oil	
Colour	0.00 ± 0.00	1.33 ± 0.33	0.33 ± 0.33	0.031
Odour	0.00 ± 0.00	1.33 ±0.33	0.00 ± 0.00	0.004
Flavour	0.00 ± 0.00	1.00 ± 0.58	1.00 ± 0.00	0.125
Tenderness	1.00 ± 0.00	1 ± 0.00	0.67 ± 0.33	0.630
Overall acceptability	0.00 ± 0.00	1.00 ± 0.00	0.67 ± 0.33	0.027

Texture/tenderness

The impression of how hard, soft, rough and smooth egg, sausage and beef fried with the oil samples were rated by the panellist and illustrated in the figure below

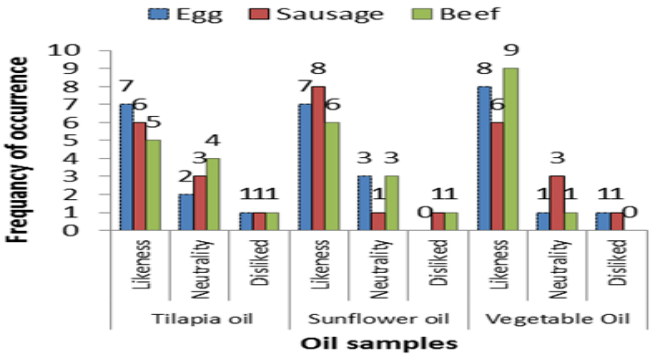

Figure 3. Rating for texture/tenderness

Panellist liked the texture/tenderness of egg fried with sunflower (7 points) as those fried with Tilapia (7 points) oils. The tenderness of sausage fried with sunflower oil (8 points) was rated highest and least for vegetable (6 points) and Tilapia (6 points) oils. In beef, vegetable oil (9 points) was liked most and tilapia oil (5) was rated least

Ratings for neutral expression by panellist were as follows: with eggs, no/zero scores for Tilapia oil, 3 points for sunflower oil and 1 point vegetable oil. Sausage fried with vegetable oil (3 points) was highest and sunflower oil (1 point) was lowest. Beef fried with tilapia oil (4 points) also rated highest with vegetable oil (1 point) scoring the lowest.

Panellist that dislike the tenderness/texture of egg, sausage and beef when fried with the oil samples showed that, for all three food , thus egg, sausage and beef the expression were the same as the scores (1 point each) were same for all. Also the score for sausage fried in all three oils were same in terms of scores (1 point each). Similarly beef fried with Tilapia and vegetable oil recorded similar scores of 1 point each.

Overall acceptance

The general impression of panellist was sort for on the use of all the oil samples as use in preparing the three food items.

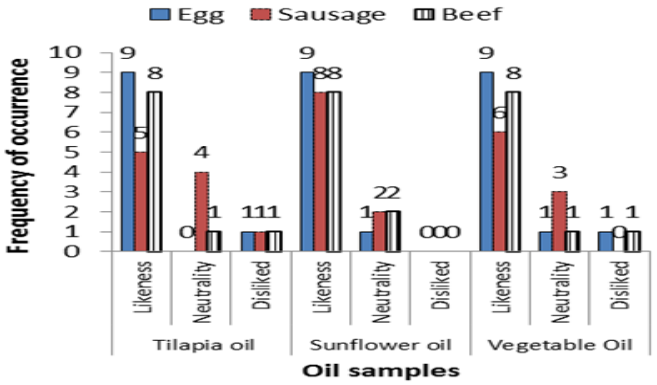

Figure 4. Rating for overall acceptability

In terms of likeness (Figure 5) for the overall acceptance, ratings were same for eggs (9 points for each oil used) and beef (8 points for each oil used) when fried with tilapia, vegetable and sunflower oils. When sausage was fried with all three oils, ratings were highest for sunflower oil (8 points) and least for Tilapia oil (5 points).

In terms of neutrality ratings, were zero or no record for eggs fried with Tilapia oil. However, for sausage, Tilapia oils recorded the highest (4 points) and sunflower oil recorded the least (2 points). For beef, sunflower oil was the highest (2 points). For the three food samples used in this study, the oils samples had equal tally ratings of 5 point each.

Among panellist that disliked the influence of the oil sample on the overall acceptance of the food samples, zero record for eggs, sausage and beef indicate no dislikeness for use of sunflower oil.

Analysis of variance

In Table 1, the means of foods (eggs, sausage and beef) prepared using all three oils in terms of likeness for colour, odour, flavor, tenderness, and overall acceptability showed no ($p > 0.05$) significant differences.

In Table 2 , the means of foods (eggs, sausage and beef) prepared using all three oils in terms of neutral ratings for colour, odour, flavor, tenderness, and overall acceptability showed no ($p > 0.05$) significant differences.

In Table 3, the means of foods (eggs, sausage and beef) prepared using all three oils in terms of dislike ratings for colour, flavor, tenderness, and overall acceptability showed significant ($p < 0.05$) differences. However, tenderness was not significantly ($p > 0.05$) different for the food prepared with all test oils.

Discussion

Sensory qualities such as colour, flavour, aroma, and texture are strong determinants of alimentary behaviour. Frying is an ancient food cooking processes currently used at home and in industries [5]. The frying process gives a rapid and uniform product heating. Frying oil acts as a heat transfer medium and contributes to the colour, texture and flavour of fried food, hence making fried foods very popular to consumers. The high temperatures used (175-185°C) "seal" the surface of product, preventing a rapid loss of steam, thus facilitating the cooking of the interior and allowing the product to become more juicy [9]. Deep-fat frying produces desirable or undesirable flavour compounds, changes the flavour stability and quality, colour, and texture of fried food and the nutritional quality of food [7].

Colour is one of the most important physical attributes that greatly influences consumer perception and can summarily lead to rejection of a product [10]. In the acceptance of fried foods can be traced to attractiveness of the colour of the food, however, if that colour of foods deviates from a known and long stay colour "normal colour" then that food would probably be rejected. In figure 1, though some food were rated highest with respect to the use of different oils, the fact that no significant differences (Table 1) occurred, is an indication that the different oils did not impact 'abnormal' colours to the food. In addition, the rating for "like" top the other general descriptions of acceptability of food thus "dislike" and "neutral" is an indication that all three oils had no negative effect on the colour of eggs, sausage and beef when fried. This is an indication that, regardless of the type of oil used, once the colour of the food is not changed from the regular colour known, the greater likelihood of the consumer accepting such food is high. It also indicates that low cost oil such as that of Tilapia oil that did not undergo any industrial processing can compete favourably with vegetable and sunflower oils. This arouses the need to promote the extraction and use of Tilapia oil as an innovative measure to increase the economic value of farming fish and a good measure to reduce waste generation from fish processing.

[1] mentioned that, aroma (odour or smell) gives an indication of the degree of attraction or repulsion of consumers to food substance. Consumers of a product are attracted or repelled to it by means of its odour. Pleasing aromas attracts consumers, while irritating odour repels them [2]. Generally, there were more panellist who "liked" or were pleased with the smell of eggs, sausage and beef fried with all three test oils than those not able to decide (neutral) and those who were not pleased (dislike) with the odour produced by the test oils. Therefore, the use of any of these three oils would attract more consumers than would repel. It may imply that the use of Tilapia oil be promoted to add to the already commercially existing oils (sunflower and vegetable oils amongst others). Tilapia oil extracted and refined industrially may have an enhanced effect on the aroma that will emanate from foods prepared with it. However, as reported in [4] care is needed to preserve the properties of fish oil such as its richness in linolenic and linoleic acids from oxidizing as a result of the deodorization process. In this way the health benefits (e.g. a lower risk of coronary heart disease and improvement in cholesterol), associated with consumption of food containing fish oil would be fully realized.

In a report by [2] flavour is the outcome of combining the senses of smell; taste and mouth feel by a consumer. Flavour, represents a group of sensations including odors, tastes, and freshness or pungency. Therefore, the flavour compound (chemical) profile of food ingredients is a natural starting point for a systematic search for principles that might underlie our choice of acceptable ingredient combinations [3]. In our study, indications of no significant ($p > 0.05$) differences in the use of all-three oils in preparing all-three foods for like, neutral and dislike ratings could mean similar ingredient interactions, (thus food and oil interactions for all three test combinations). These points to the fact that all test oils and text food have if not the same, very similar compounds that influenced the judgment of panellist in one direction. There is the need to conduct test on ingredients to be combined to know if they have similar compounds that could react to produce an outcome (i.e. pleasant or unpleasant). This could help in developing a theory. However, with 'Like' rating topping the scores of 'neutral' and 'dislike' implies strong acceptance. It therefore means that the ingredient combination in this study shared flavour compounds that resulted in a pleasant taste. It means that for any test ingredient combination, that do not share flavour compounds are more likely to not to taste well [3].

Expectations are important to textural perceptions and preferences. The role of consumer expectations on the acceptance of is a function of the degree to which expectations about particular foods are matched to actual experience. However, no texture-related expectations were examined in this study. Texture awareness increases substantially if the texture does not meet expectations. When expectations are not filled, it may easily lead to rejection of a particular food.

In Table 1, there were no significant ($p > 0.05$) differences for foods fried with all-three test oils. It means that, the ingredient combinations involving vegetable, Tilapia and sunflower oils with eggs, sausage and beef do not result in products that are different in terms of how soft, hard, rough or smooth a food will be after frying. Actually, it implies that foods prepared using any of these test oils is very likely to have similar textures. General, like ratings were significantly higher that neutral and dislike ratings (i.e. significantly higher frequency of occurrence, see Table 1, 2 and 3). This shows good acceptance of foods, perhaps because the oils might have influence the texture food products positively. [7] explained that frying foods in oil can results in desirable textures and undesirable textures. Foods fried at the optimum temperature and time produces the desirable textures whiles those under fried or over fried are likely to produce undesirable textures. It is therefore important to ensure that foods prepared using oils are fried under optimum temperatures and time to produce products with the right textures. This can enhance consumer acceptance.

Many factors influences the general acceptance of food by consumers, although these sensory characteristics are subjective, they are very important for our overall understanding of food consumption, along with other characteristics such as aroma, flavour, and texture. The appearance of food can stimulate or inhibit appetite Collins & Plumbly (1995) cited in [8]. When overall acceptability score of prepared patties was estimated, the highest ratings was obtained for "like" rating (Table 1) for all test food with all test oils, followed by "neutral" rating (Table 2) and the lowest "dislike" rating (Table 3). A significantly higher

ratings for "like" evident that the test oils impacted positively on the test food. The likeness for eggs, sausages and beef prepared using vegetable oil, Tilapia oil and sunflower oil indicates no significant ($p > 0.05$) differences for the sensory attributes of colour, odour, flavour, texture and overall acceptability. This implies Tilapia oil is a suitable contender to other food oils. The significant differences ($p < 0.05$) in dislike ratings (Table 3) for sensory attributes could mean that there are bound to be some discrepancies among consumers in expressing their thoughts about the extend which they dislike the effects of using different on foods.

Conclusion

The study showed no significant variation in terms the colour, odour, flavour, texture and overall acceptability of food that were fried with Tilapia, Vegetable and Sunflower oils. The ratings for "like" were not significantly different for sausage, beef and eggs for all sensory attributes likewise the ratings for "neutral" and "dislike" The study shows that Tilapia oil has a good potential for use in the preparation of food. Tilapia oil can compete favourable with widely use commercial market oils such as vegetable and sunflower oil.

Recommendations

Value addition may be necessary for Tilapia oil to improve quality as in purity and maintenance of chemical and physical properties.

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