Effects of Different Levels of Seaweed (*Eucheuma spinosum*) on the Sensory Qualities and Selling Price of Fish Balls

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Abstract— *The study aimed to determine the sensory qualities and selling price of fish balls with the different levels of seaweed (Eucheuma spinosum). Five treatments were applied in this study; Control (0 seaweed), T_1 (25% seaweed), T_2 (50% seaweed), T_3 (75% seaweed), and T_4 (100% seaweed). Experimental samples were laid out using a completely Randomized Design (CRD). Different samples were subjected to sensory evaluation and selling price determination. Results were analyzed using ANOVA and DMRT when treatments were found to be significantly different from each other. Results revealed that different combinations of fish and seaweeds significantly affected the sensory qualities of fish balls in terms of color, aroma, flavor, texture and general acceptability. The treatment with the least amount of seaweed added showed the highest sensory score in all the sensory parameters.*

Keywords— Seaweed processing, fish balls, sensory evaluation, consumer acceptability.

I. INTRODUCTION

Figures from FAO (2004) and the Seaweed Industry Association of the Philippines showed that seaweed farming is one of the largest and most productive sources of income among coastal communities of the Philippines. Majority of the harvested seaweeds are either processed into carrageenan or simply sun dried (FAO, 2004) as a result, some of its essential nutrients are lost. It is well documented that extracts from seaweeds are abundant in polyphenolic compounds which are recognized for their antioxidant properties (Wang, Jónsdóttir, & Ólafsdóttir, 2009; Athukorala, Lee, Song, et al., 2003). Seaweed extracts also contain antimicrobial properties against major food pathogenic and spoilage microorganisms like E. coli (Gupta, Rajauria, & Abu-Ghannam, 2010). Seaweeds are known to be rich in important minerals such as iodine and dietary fibers (Kolb, Vallorani, Milanovic, &Stocchi, 2004). Moreover, there is a growing trend towards the use of "natural green" plant extracts in various food and beverages industry.

Seaweed, known for its structurally diverse bioactive compounds, can be used as an ingredient to supplement food with functional compounds. The concern of the application of such compounds as natural antioxidants, antimicrobials or texturing agents in different food products is being closely studied. Moreover, the utilization of seaweeds as food additives will lessen the use of chemical preservatives. The important role of diet in human health has recently been gaining attention. Functional food or food that is beneficial not just due to the presence of essential nutrients but also other properties which have been recognized for health promotion and disease prevention are gradually taking consideration in food industries. Beneficial effects of functional foods can be brought about by its mixture of antioxidant, antimicrobial, anticancer and antiviral activities. Seaweeds (*Eucheuma spinosum*) locally known as *guso* are abundantly growing in the Philippines especially in the Central and Eastern Visayas (FAO, 2004). Marine macroalgae are considered one of the richest sources of antioxidants (Chen, Lim, Sohn, Choi & Han, 2009). They are also a good source of vitamins and folic acid as well as minerals such as Na,Ca, K, P and I (Dhargalkar & Pereira, 2005). Sugars from seaweeds also possess prebiotics and other biological activities which could be useful for medical (Smit, 2004).

In many ASEAN countries, *Eucheuma* seaweeds are commonly consumed fresh like in salads. They are also processed into carrageenan a gelatinous extract from seaweeds used for their gelling, thickening, and stabilizing properties, however, current studies added their potential medicinal uses against cancer and other forms of diseases as one of its many benefits (Mohamed, Hashim & Rahman, 2011). Considering the abundant and growing supply of *guso* in the country and its many functional properties, it is therefore important to increase the consumption rate of this wonder seafood by producing other food products from it. The increase in demand of different food products from *guso* is expected to boost seaweed production in Eastern Visay as which will lead to generation of livelihood in the coastal communities. Developed food technologies have been used in extension programs by universities to improve economic status of its constituents (Pascual and Estolano, 2017). As a functional food, it will also promote good health among consumers. The increase in the usefulness of seaweeds just like

producing new food products from this raw material like fish ball will make its bioactive components readily available in ready to eat form. Thus, this study aims to develop fish balls with seaweeds and determine its' sensorial qualities as well as market potential.

II. MATERIALS AND METHODS

2.1 Procurement of Ingredients and Raw Materials

All ingredients in making fish balls as well as the seaweeds used in the study were bought from the public markets in Sogod, Southern Leyte.

2.2 Experimental Design

The samples in the study were laid out in Complete Randomization Design (CRD). Various levels of seaweeds (0, 25%, 50%, 75% and 100%) were used as treatments.

2.3 Preparation of the Product

2.3.1 Preparation of Fish

Fish were cleaned and cooked with following the procedure and ingredients: 0.60g black pepper, 200 mL vinegar, 30g ginger, 30g garlic, 1 teaspoon salt, 5g MSG, 1,500g fish, and 237 mL water were placed in a casserole with a cover and cooked for 30 minutes. After cooking, fish were placed in a plate and then shredded into flakes.

2.3.2 Preparation of Seaweed

Fresh seaweeds were blanched in boiling water for 10 seconds and were chopped into fine pieces and set aside before use.

2.3.3 Preparation of Fish balls

Fish balls were processed following the procedure of Fabian (2008). 250g of fish flakes was placed in a mixing bowl added with 100 of eggs, 30g chopped onions, 30g onion stalk, 25g chopped celery, 250g all – purpose flour, 30g baking powder, 5g baking soda, 30gsalt, 20g sugar, 1g black pepper and 30 mL evaporated milk. Then seaweeds were added into the mixture following the different treatment formulations and were thoroughly mixed using a wooden ladle. The mixtures were shaped into balls (30 grams) and were rolled over a plate with flour to hold its shape. The fish balls were then steamed for 15 minutes. The steamed fish balls were stored inside the freezer for 24 hours before cooking. The fish balls were cooked by deep frying them for 15 minutes or until golden brown.

2.4 Sensory Evaluation

All sensory evaluation activities were carried out to determine the acceptability of the fish ball products from the different treatments right after freezer for a day. Samples were evaluated by 60 sensory panels that assessed the products' color, aroma, flavor, texture, general acceptability. The standard procedures on concluding sensory evaluation by Mabesa (1998) was followed using the 9 – point Hedonic Scale. Sensory evaluation was replicated twice.

2.5 Production Cost and Selling Price Determination

The selling price per piece of fish balls was computed. The computation for the production cost and selling price were based on the following formula:

$$Unit\ cost = \frac{\text{Raw Food Cost}}{\text{Yield}} \quad (1)$$

$$\text{Selling Price} = \frac{\text{Unit Cost}}{\text{Food Cost Percentage}} \quad (2)$$

$$\text{Total Selling Price} = \text{Selling Price x Yield} \quad (3)$$

Where:

UC = Unit Cost

RFC = Raw Food Cost

FCP = Food Cost Percentage

Y = Yield

SP = Selling Price

TSP = Total Selling Price

2.6 Statistical Analysis

Data gathered from the experiment were subjected to Analysis of Variance (ANOVA) to determine significant effects among treatments. When treatments effects were found significant, Duncan's Multiple Range Test (DMRT) was used to determine the significant difference between treatments.

III. RESULTS AND DISCUSSION

3.1 Appearance of the Different Treatments

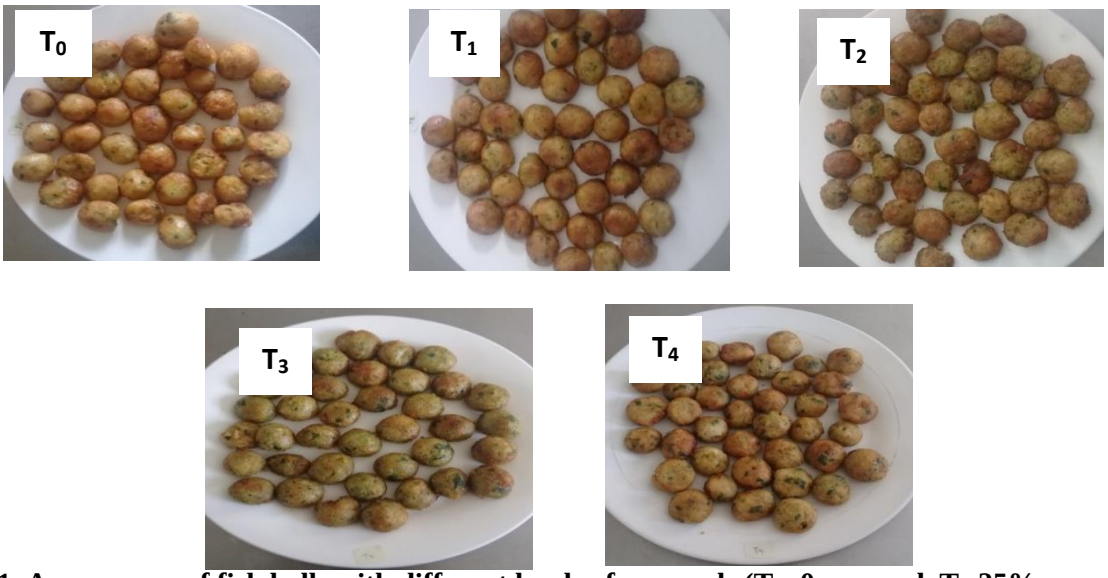

FIGURE 1. Appearance of fish balls with different levels of seaweeds (T_0- 0 seaweed, T_1-25% seaweed, T_2- 50% seaweed, T_3- 75% seaweed, T_4 – 100% seaweed)

3.2 Sensory Evaluation

TABLE 1
MEAN SENSORY SCORES OF THE DIFFERENT TREATMENTS USING 9-POINT HEDONIC SCALE

Treatment	Sensory Parameter*				
	Color Acceptability	Aroma Acceptability	Flavor Acceptability	Texture Acceptability	General Acceptability
T_0	7.80^{a}	7.61^{a}	7.23^{a}	7.33^{a}	7.36^{ab}
T_1	7.70^{a}	7.63^{a}	7.36^{a}	7.43^{a}	7.50^{a}
T_2	6.98^{b}	7.03^{b}	6.83^{ab}	6.96^{ab}	7.03^{abc}
T_3	6.63^{b}	6.95^{b}	6.35^{b}	6.31^{c}	6.50^{c}
T_4	6.88^{b}	7.00^{b}	6.55^{b}	6.66^{bc}	6.83^{bc}

T_0- 0 seaweed, T_1-25% seaweed, T_2- 50% seaweed, T_3- 75% seaweed, T_4 – 100% seaweed
****means with the same letters are not significantly different***
Hedonic rating scale: 9- like extremely, 8-like very much, 7-like moderately, 6-like slightly, 5-neither like nor dislike, 4-dislike slightly, 3-dislike moderately, 2- dislike very much, 1- dislike extremely

3.2.1 Color Acceptability

The use of different levels of seaweeds significantly affected the color acceptability of fish balls as shown in Figure 1 and Table 2. Highest color acceptability was observed in T_0 (Control) with a score of 7.80. The color acceptability score of T_1 (25% seaweed) which is 7.70 was comparable to the control. The high color acceptability scores of both T_0 and T_1 could be attributed to its golden brown color, a color typical for fish balls. In contrary, as the levels of seaweeds was increased in the fish ball formulation such as in T_2 (50% seaweed) and T_3 (75% seaweed), the color acceptability of the fish balls significantly

decreased. This means that the addition of more seaweeds resulted to additional green color in the fish balls which consumers find it not likeable. Nevertheless, in terms of color acceptability, T_2, T_3 and T_4 scored fairly 6.98, 6.63 and 6.88 respectively which is within the range of "like slightly" to "like moderately" in the Hedonic scale

3.2.2 Aroma Acceptability

As presented in Table 1, the aroma acceptability of the different fish ball treatments was significantly affected by the various levels of seaweeds. The fish ball with the least amount of seaweed added (T_1) gave the highest aroma acceptability (7.63). The aroma acceptability of T_1 did not differ significantly from T_0. Moreover, the addition of more seaweed (T_2, T_3 and T_4) lessens the consumer acceptance of the fish balls in terms of aroma. It is important to note that the addition of small amount of seaweed improves the aroma of the fish balls but that increasing further the seaweed level decreases the aroma acceptability.

3.2.3 Flavor Acceptability

In terms of flavor acceptability, the different levels of seaweeds significantly affected the flavor of the fish balls (Table 1). The addition of small amount of seaweeds (25%) resulted to fish balls with the highest flavor acceptability (7.36). This could imply that seaweeds particularly in smaller amounts improve the texture of fish balls. Consequently, the addition of 50% seaweeds (T_2) also produced fish balls with comparable flavor with the control sample and T_1. The treatment with the largest amount of seaweeds (T_3) scored the least in color acceptability which is 6.35 but still falls between "like slightly" and "like moderately" in the Hedonic scale. This indicates that even the addition of larger amount of seaweeds could still produce fish balls that are still acceptable to consumers.

3.2.4 Texture Acceptability

As presented in Table 1, the texture acceptability of the different fish ball treatments was significantly affected by the various levels of seaweeds. The fish ball with the least amount of seaweed (T_1) gave the highest texture acceptability score (7.43). The texture acceptability of T_1 did not differ significantly from T_0 and T_2. Moreover, it is important to note that the addition of small amount of seaweed improves the texture of fish balls but that increasing further the seaweed level decreases the texture acceptability of the samples. Increasing the amount of seaweeds resulted to tougher fish balls in which consumers find it undesirable.

3.2.5 General Acceptability

In terms of general acceptability, the different levels of seaweeds significantly affected the sensorial qualities of the fish balls (Table 1). The addition of small amount of seaweeds (25%) resulted to fish balls with the highest general acceptability (7.50). This could imply that seaweeds particularly in smaller amounts improve the general acceptability of fish balls. Moreover, the addition of 50% seaweeds (T_2) also produced fish balls with comparable overall acceptability with the control sample. The treatment with the largest amount of seaweeds (T_3) scored the least in color acceptability which is 6.50 but still falls between "like slightly" and "like moderately" in the Hedonic scale. This indicates that even the addition of larger amount of seaweeds could still produce fish balls that are still acceptable to consumers. With the high acceptability ratings of the seaweed-fish ball samples, it can be introduce to school canteens however, its microbial safety and quality must be determined. In a study conducted by Pascual and Abenis (2016) in selected school canteens in Eastern Visayas, Philippines, 9 out of 15 public high schools showed poor sanitary practices leading to the presence of high number of microorganisms in foods served.

3.3 Production Cost and Selling Price Analysis

TABLE 2
COST OF PRODUCTION AND SELLING PRICE PER PIECE OF FISH BALLS*

Treatment	Production Cost (Php)	Selling Price (Php)
T_0	4.00	5.00
T_1	3.50	4.50
T_2	3.00	4.00
T_3	2.50	3.50
T_4	2.00	3.00

T_0- 0 seaweed, T_1-25% seaweed, T_2- 50% seaweed, T_3- 75% seaweed, T_4 – 100% seaweed
****30g sample***

IV. CONCLUSION

Based on the study conducted, the addition of seaweed has greatly affected all the treatment in terms of the color, aroma, flavor, texture and general acceptability. Comparing all treatments, T_1 scored the highest in all sensory parameters being evaluated. Increasing the amounts of seaweed added to fish balls resulted to decrease in sensory attributes however, lowers the production cost and selling price of the products.

RECOMMENDATION

Proximate composition analysis should be conducted on the different seaweed fish ball samples to have information about its nutritional contents. An expanded market research for the product or any product of similarity may also be important to validate and refine assumptions for the product entry in a well-defined market environment. Furthermore, market testing of the product must also be conducted. Further work on establishing the shelf life of the product must be conducted especially at longer storage period. Shelf-life study should also be conducted on packaged ready-to-fry seaweed (steamed) fish balls.

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