Snack Bars Enriched with Tilapia

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Snack bars (SBs), well-known as cereal bars, have been commonly consumed worldwide because they provide instant energy and are convenient to carry around. SBs moderate direct hunger and influence people's nutritional status, which is commercially and nutritionally interesting. Most consumers care for their diet and health. Thus, eating SBs can be a source of intake of beneficial nutrients, such as fiber, protein, minerals, and vitamins. SBs are common oat (Avena sativa)-based products, a cereal technological feature that also supplies health benefits and cholesterol-lowering properties associated with β-glucan, a soluble-type dietary fiber. However, oat-based SBs are typically deficient and limited in their amino acid profile, especially in threonine and methionine. This condition can be improved by adding complementary protein sources such as legume or animal proteins (good sources of threonine and methionine), increasing the protein and fiber content and improving the bioactive content in the product.

Keywords: snack bars ; tilapia by-products ; antioxidant ; ACE inhibitor ; antibacterial

1. Overview

Tilapia by-product powders were made by two processing methods; one powder was oven-dried as tilapia dry powder (TDP) and another was bromelain-hydrolyzed and then freeze-dried as tilapia hydrolysate powder (THP). SBs were prepared by incorporating tilapia dry powders (TDP or THP; 10%). SBs were further separated in two different cooking methods, namely unbaked and baked ones. The baked SBs had yellow and darker coloration (L* value ranged from 66.38 to 76.12) and more reddish color (a* value range from −1.26 to 1.06). Addition of tilapia by-product powders significantly ($p < 0.05$) increased the protein content of the original SB from 21.58 to 32.08% (SB + THP). Regarding DPPH scavenging activity, the control group showed the lowest activity, followed by SB + TDP and SB + THP with the highest activity ($p < 0.05$), with DPPH scavenging activity ranged from 12.40 to 26.04%. The baking process significantly ($p < 0.05$) increased the angiotensin converting enzyme (ACE) inhibitory activity of the SBs. In particular, the SB + THP group showed the highest activity (17.78%). All samples exhibited antibacterial activity against *Staphylococcus aureus*, and the SB + THP group showed the highest activity (15.08 ± 1.95 mm growth inhibition). Based on principal component analysis, four principal components (nutraceutical pigmentation, physical characteristics, nutrition value, and greater dehydration) were contributed towards the physicochemical and functional properties of the SBs. The overall results suggested that tilapia by-product powders can be potential ingredients for adding functional values to food products.

2. Snack Bars

Snack bars (SBs), well-known as cereal bars, have been commonly consumed worldwide because they provide instant energy and are convenient to carry around. SBs moderate direct hunger and influence people's nutritional status, which is commercially and nutritionally interesting [1]. Most consumers care for their diet and health. Thus, eating SBs can be a source of intake of beneficial nutrients, such as fiber, protein, minerals, and vitamins [2].

SBs are common oat (*Avena sativa*)-based products, a cereal technological feature that also supplies health benefits and cholesterol-lowering properties associated with β-glucan, a soluble-type dietary fiber [3]. However, oat-based SBs are typically deficient and limited in their amino acid profile, especially in threonine and methionine. This condition can be improved by adding complementary protein sources such as legume or animal proteins (good sources of threonine and methionine), increasing the protein and fiber content and improving the bioactive content in the product [4].

Animal and plant proteins have different effects on muscle health. In addition, dietary proteins from different food sources are usually different in their protein content, amino acid composition, and protein digestibility. Animal-based foods are the primary source of high-quality protein. Previously, studies have shown that higher animal protein intake is associated with greater muscle mass and less muscle loss in older Americans and Europeans [5].

Functional compounds in animal and plant-based food products and by-product supplementation have been developed by food industries [6]. One of the cases is in Nile tilapia (*Oreochromis niloticus*) industries. Tilapia is one of the main freshwater fish species that have a significant contribution to global aquaculture growth. In the tilapia fillet industry, the fillet yield is approximately 30%, whereas the other parts of tilapia, tilapia by-products, are identified as waste or under-utilized biomaterials. Waste management could be a strategy to reduce food waste's economic, social, and environmental impacts. It can reduce food wastage, redistribute unsold or excess food, and recycle/treat food waste/by-products [7].

Tilapia dry powder (TDP) from the frame with meat fit to bones is relatively easy to prepare. This powder is not only affordable but also containing high-quality nutrients, incredibly high levels of essential amino acids (histidine, lysine, threonine, methionine, valine, and leucine) and polyunsaturated fatty acids (alpha-linolenic acid (C18:3n3), eicosatrienoic acid (C20:3n3), gamma-linolenic acid (C18:3n6), and docosadienoic acid (C22:2) [8]. More importantly, another alternative option to reuse the waste is to process the frames with enzymatic hydrolysis and powder them into tilapia hydrolysate powder (THP). In our previous work, regarding the combination of proteomic techniques and in silico analysis, enzymatic hydrolysis can regenerate and change the functional and physicochemical attributes of the food product. Subsequently, there is an idea to carry on the nutritive value of the hydrolyzed proteins and make healthier products. The high nutritional value of the hydrolysates was shown by their protein contents and amino acid profiles [9][10]. In addition, an in vitro assay of the hydrolysates and peptide fractions demonstrated varying bioactivities, including ACE inhibitory, DPPH radical scavenging, reducing power, and antibacterial activities [11].

To conclude, SBs can be important vehicles for transporting these ingredients and providing bioactive compounds to the human diet [12]. Consequently, this paper aimed to evaluate tilapia fish by-products as a novel food ingredient to analyze different physicochemical and functional properties among SBs enriched with TDP and THP. Meanwhile, considering the importance of cooking method diversification on enriched food products, the effects of different cooking methods, baking and no baking, on the physicochemical and functional properties (including the antioxidant, ACE inhibitory, and antibacterial activities) of the enriched SB production were investigated and compared.

3. Conclusions

SBs were prepared with the addition of tilapia dry powder and tilapia hydrolysate powder. From the physical point of view, baked SBs had higher hardness than unbaked SBs. However, baked SBs showed darker colors because of caramelization's browning compounds. The addition of these materials to SBs enhanced the nutritional value of the products by increasing the protein and fat content and influence the energy produced. In these SBs, all samples exhibited potential for DPPH scavenging activity, ACE inhibitory activity, and antibacterial activity. In particular, SB + THP showed the highest activity. More functional properties were observed in SB + THP because of the bioactive peptides from THP. However, SB + TDP was still recommended for production due to the convenience of preparation with good functional properties. Principal component analysis reported that physicochemical and functional properties contributed 83.73% to overall quality and were separated into four principal components: nutraceutical pigmentation, physical characteristics, nutritional value, and greater dehydration. It is suggested that tilapia by-product powders (both TDP and THP) can be alternative options for adding nutraceutical values to food products.

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