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RESEARCH ARTICLE

Effectiveness of Pitaya Pulp Incorporated to Wheat Flour in Bread Making

Nguyen Phuoc Minh

Faculty of Natural Sciences, Thu Dau Mot University, Binh Duong Province, Vietnam.

Abstract

There has a trend towards the consumption of functional foods beneficial for human health. Bread is one of the most important staple foods in the world. Pitaya pulp is a rich source of nutrition like carbohydrate, pectin, crude fibre, vitamin and minerals. It also contains a great amount of phytochemical constituents like phenolics, flavonoids. It would be of functional benefit if wheat flour could be substituted by pitaya pulp to utilize anthocyanin pigment in adherent as natural valuable colorant in bread-making. We have attempted in the application of composite flour through the incorporation of pitaya pulp into wheat flour to improve nutritional quality of bread. In this study, pitaya pulp was utilized to substitute refined wheat flour in bread-making doughs at 3.5%, 5.0%, 6.5%, 8.0%, 9.5% substitution levels. Various variables of texture firmness (g), specific loaf volume (cm^3/g), water activity (a_w), rancidity (meq O_2/kg fat), total phenolic (mg GAE/ 100g), total flavonoid (mg GE/ 100g) and sensory characteristics of bread were carefully observed. The substituted bread-making with 8.0% pitaya pulp had the improved firmness, rich in total phenolics and flavonoids but low in rancidity. During 7 days of storage in OPP/LLDPE pouch at ambient temperature, the physico-chemical, microbial and sensory characteristics of bread still satisfied to acceptable level.

Keywords: *Bread, Pitaya, Firmness, Specific loaf volume, Water activity, Phenolic, Flavonoid, Rancidity.*

Introduction

The demand for processed food is increasing rapidly with increasing urbanization. Bread is one kind food widely consumed around the word. It is made from wheat flour, yeast, sugar, fat, salt, and water in a series of manupulations such as mixing, kneading, fermentation, proofing and baking [1]. Wheat contains huge amount of gluten making raised loaves so it's an ideal choice in bread-making [2]. Legumes have gained special attentions in preparation of bread [3]. Sugar is the primary ingredient for the yeast metabolism in bread-making to release of carbondioxide gas.

Sugar improves the crust color through browning reaction. It also acts in texture improvement, tenderness, anti-staling, preservative, moisture retention. Composite flours have become popular due to two main reason namely nutritional and economic benefits [4, 5]. It might be beneficial to apply substitute originated from available local horticulture resource to enhance commercial profit as well as to cut down imported charge from wheat [6, 5].

The utilization of pitaya fruit in the manufacture of value-added bakery may bring more profit to consumers and local processing industries. There were several literatures mentioned to the fortification of substituted fruit pulp into bread-making dough. Apple pomace pulp powder was incorporated in refined flour as dietary fibre for bread making [7]. The proximate, physical and sensory analysis of bread samples produced by substituting the level of date palm fruit pulp (50:0 g, 37.5:12.5 g, 25:25 g, 12.5:37.5 g and 0.50 g) was investigated [8].

One study investigated the implementation of waste residue from pineapple fruit as an added value to bakery [9]. Bread made by replacing fruit powders (banana -10%, 20%; aonla - 5%, 10%; sapota - 10%, 20%) at various ratios were examined on different physico-chemical and organoleptic attributes [10].

Supplementation of jackfruit rind powder as a high dietary fiber and functional ingredient

in bread was examined [11]. There was not any research mentioned to the application of pitaya pulp as a substitution to wheat flour in bread making. Pitaya (*Hylocereus* spp.) fruit has delicate and sweet flesh with intense white color of the flesh and red-purple color of fruit extract [12]. It's often consumed fresh, flavouring agent in drinks jams and ice cream, sherbets, yogurt, candy and pastries [13, 15].

It's a rich source of fiber, vitamins, minerals, phytochemicals and antioxidants [16, 18].It is also known to possess medicinal and pharmaceutical properties to prevent diabete, cancer, toxin [19]. Therefore, objective of this our study focused on the feasibility of pitaya pulp incorporated into wheat flour in the physico-chemical, microbial and sensory characteristics of bread.

Material and Method

Material

Pitaya fruits were come from Tien Giang province, Vietnam. They were harvested at ripen maturity stage, peeled to get edible pulp, ground by electric grinder into mash ready for bread making. Wheat flour was purchased from Dai Phong Co. Ltd. Other ingredients such as casava starch, shortening, refined sugar, salt, lecithin, butter, dried yeast etc were purchased from commercial supermarket.

Researching Procedure

Dried yeast was primarily activated in warm water. Salt and sugar were also dissolved in water before adding into flour. Pitaya mash was incorporated by different substitution ratio (3.5%, 5.0%, 6.5%, 8.0%, 9.5%) into wheat flour. Bread-making was prepared by mixing wheat flour with active yeast and other ingredients and then kneaded to soft and smooth consistency using dough mixer for 15 minutes.

The dough was fermented to double size for 60 minutes at ambient temperature. After fermentation, dough was divided into pieces of 250g and moulded to desired shape. The dough was allowed to proofing in mould for more 30 minutes to obtain maximum possible size. It was baked at 250^{o}C for 25 minutes. Loaves were taken out, cooled and packed in OPP/LLDPE pouch ready for preservation in 7 days.

Physico-chemical, Sensory and Statistical Analysis

Texture firmness (g) was evaluated by texture analyzer. Specific loaf volume (cm^3/g) was estimated by dividing the loaf volume by loaf weight. Water activity (a_w) was measured by a water activity meter. Total phenolic content (mg GAE/100g) was evaluated using Folin-Ciocalteu assay [20]. Total flavonoid content (mg GE/100g) was avaluated by the aluminum calorimetric method [21].

Rancidity (meq O_2/kg fat) was determined by mixing sample with a diluted acidic potassium iodide solution and titrating against a 0.1 M sodium thiosulfate using starch indicator. Total plate count (cfu/g) was quantified by 3M-Petrifilm. Sensory score was evaluated by a group of panelist using 9 point-Hedonic scale. The experiments were run in triplicate with three different lots of samples. Statistical analysis was performed by the Stat graphics Centurion XVI.

Result & Discussion

Physico-chemical, Microbial and Organoleptic Characteristics of Bread Fortified by Pitaya Pulp

Water activity plays a key role in physical characteristics such as texture and in the shelf life of foods by lower the availability of water for microbial proliferation [10].In our research, different substituted ratios of pitaya pulp (3.5%, 5.0%, 6.5%, 8.0%, 9.5%) to bread-making dough were demonstrated.

A significant increase in texture firmness and decrease in specific loaf volume were observed with increased incorporation of pitaya pulp. It might be due to a decrease in the proportion of the gluten content which is an important protein responsible for maintaining the viscoelastic property of bread dough which ensures the increased volume of bread [22].

It could be explained via less retention of carbon dioxide gas in the blended dough resulting in dense bread texture. Gluten is responsible for the elasticity and framework of the loaf during baking. A decreasing trend in specific loaf volume with a progressive increase in the proportion of non-gluten flour was also mentioned [23, 25]. The inclusion of pitaya pulp into dough created darkening effect, reduced lightness of bread.

It's a result of Maillard reaction between reducing sugar and protein due to incorporation of pitaya fruit.

Bread flour substituted by fruit pulp rich in dietary fiber was able to entrap much more moisture than wheat flour [26]. It could be explained that the high moisture absorption of fiber rich powder was attributed to the higher number of hydroxyl groups existed in the fiber structure permitting more moisture interaction through hydrogen bonding [27]. Wheat flour is a poor source of total phenolics and flavonoids. Pitaya pulp has a rich potential of phytochemical components.

The bread substituted with pitaya pulp had higher total phenolics and flavonoids than the traditional bread recipe. It implied the possible advantage of incorporating fruits in bread making in terms of upgrading its antioxidant capacity. In our research, it's obviously seen that 8.0% Pitaya pulp was appropriate to substitute wheat flour during bread-making. Generally, loaf volume and sensory quality such as texture, appearance and flavour decreased if wheat substitution increased with non-wheat flour [4]. Incorporation of pomace decreased the loaf volume of bread. The crumb colour of treated breads was brownish cream. The breads were less soft in texture and slightly coarse grains [7]. The specific volume also decreased as the level of the date palm fruit increased [8]. A 50% whole wheat flour and 50% refined flour was incorporated with pineapple powder at 5%, 10%, 15% and 20% levels into the standardized cakes. The cakes were highly acceptable at 5% incorporation [9].

The addition of extra water improved the textural properties and appearance of banana flour- steamed bread [28]. Supplementation of fruit powder improved nutritional quality in terms of crude fiber and carbohydrates. However it decreased gluten, protein and total sugar content. Breads incorporated with sapota and banana powders up to 20% and aonla powder up to 5% did not influence the organoleptic attributes [10]. Addition of jacfruit rind powder in bread enhanced functional attributes of flour such as oil holding capacity, water holding capacity and pasting properties [11].

Table 1: Effect of fortified pitaya pulp on the physico-chemical, microbial and sensory characteristics of bread after baking

Fortified pitaya pulp (%)	Control	3.5	5.0	6.5	8.0	9.5
Texture firmness (g)	103.07 ±0.03^{d}	117.42 ±0.01^{c}	120.21 ±0.02^{bc}	122.76 ±0.00^{b}	124.59 ±0.03^{ab}	126.01 ±0.01^{a}
Specific loaf volume (cm^3/g)	2.71 ±0.01^{a}	2.52 ±0.02^{b}	2.46 ±0.01^{bc}	2.37 ±0.01^{c}	2.30 ±0.03^{cd}	2.34 ±0.03^{d}
Water activity (aw)	0.43 ±0.00^{a}	0.44 ±0.01^{a}	0.45 ±0.03^{a}	0.45 ±0.03^{a}	0.46 ±0.00^{a}	0.47 ±0.01^{a}
Total phenolic (mg GAE/ 100g)	0.01 ±0.00^{d}	8.85 ±0.03^{c}	9.47 ±0.00^{bc}	9.95 ±0.02^{b}	10.19 ±0.01^{ab}	10.32 ±0.02^{a}
Total flavonoid (mg GE/ 100g)	0.01 ±0.00^{c}	1.28 ±0.01^{b}	1.51 ±0.02^{ab}	1.83 ±0.01^{ab}	1.97 ±0.03^{a}	2.00 ±0.00^{a}
Rancidity (meq O_2/kg fat)	0.36 ±0.01^{a}	0.22 ±0.02^{b}	0.19 ±0.01^{bc}	0.15 ±0.03^{c}	0.11 ±0.00^{cd}	0.08 ±0.01^{d}
Total plate count (10^1 cfu/g)	1.80 ±0.02^{d}	3.00 ±0.00^{c}	3.20 ±0.03^{bc}	3.50 ±0.01^{b}	3.60 ±0.02^{ab}	3.70 ±0.03^{a}
Sensory score	7.15 ±0.00^{d}	7.86 ±0.03^{c}	7.99 ±0.02^{bc}	8.34 ±0.00^{b}	8.74 ±0.01^{a}	8.56 ±0.02^{ab}

Note: the values were expressed as the mean of three repetitions; the same characters (denoted above), the difference between them was not significant (α = 5%)

Stability of Bread in OPP/LLDPE pouch during 8 days of Storage

Bread is commonly perishable with a short shelf-life that is limited by the physicochemical deterioration known as staling, which leads to hardening and a dry texture connected with losing the moisture of bread [29]. Pitaya has high nutritive and medicinal value with a good source of antioxidants, total phenolics, ascorbic acid, dietary fibre and pectin [15]. The water-holding capacity of dietary fiber prevents the bread from staling, which could extend the shelf-life of bread [30]. Dietary fiber improves oil and water holding capacities, reduction of syneresis, modification of textural properties, and the shelf-life of bread [31]. Supplementation of fruit pulp having high density of dietary fiber to bread dough not only prolongs the shelf-life, but also significantly improves both qualitative and organoleptic characteristics of bread [32]. Rancidity is related to the headspace and oxygen permeability of the packaging material [33]. Water activity plays a key role in bread preservation.

Nature of packaging material and its porosity plays important role in deciding moisture uptake [34]. Moisture promotes hydrolytic rancidity development [35]. Bread packed in OPP/LLDPE pouch absorbed lesser moisture during storage against air and water vapour. The substituted bread-making with 8.0% pitaya pulp still maintained the physico-chemical, microbial and sensory characteristics of bread for 7 days (see Table 2). Similar results were mentioned cereal bran incorporated biscuits [36]. Change of rancidity in preservation of buckwheat–chia flour biscuits was presented [37]. Rancidity inhibited in bread during storage could be explained by antioxidant rich fiber supplementation.

Table 2: Stability of bread in OPP/LLDPE pouch during 7 days of storage

Storage (days)	0	1	3	5	7
Texture firmness (g)	124.59 ±0.03^{b}	125.03 ±0.02^{b}	126.19 ±0.02^{ab}	130.02 ±0.02^{a}	131.16 ±0.01^{a}
Specific loaf volume (cm^3/g)	2.30 ±0.03^{a}	2.29 ±0.00^{a}	2.12 ±0.03^{ab}	2.03 ±0.00^{b}	2.01 ±0.02^{b}
Water activity (a_w)	0.46 ±0.00^{b}	0.47 ±0.01^{b}	0.48 ±0.02^{ab}	0.50 ±0.00^{ab}	0.52 ±0.03^{a}
Total phenolic (mg GAE/ 100g)	10.19 ±0.01^{a}	10.17 ±0.03^{a}	10.05 ±0.01^{ab}	10.01 ±0.02^{ab}	9.96 ±0.01^{b}
Total flavonoid (mg GE/ 100g)	1.97 ±0.03^{a}	1.96 ±0.02^{a}	1.92 ±0.01^{ab}	1.87 ±0.03^{ab}	1.80 ±0.00^{b}
Rancidity (meq O_2/kg fat)	0.11 ±0.00^{c}	0.12 ±0.01^{bc}	0.14 ±0.03^{b}	0.15 ±0.01^{ab}	0.17 ±0.03^{a}
Total plate count (10^1 cfu/g)	3.60 ±0.02^{d}	3.90 ±0.00^{cd}	4.20 ±0.02^{c}	6.10 ±0.00^{b}	7.00 ±0.01^{a}
Sensory score	8.74 ±0.01^{a}	8.70 ±0.03^{a}	8.39 ±0.01^{ab}	8.30 ±0.03^{ab}	8.17 ±0.02^{b}

Note: the values were expressed as the mean of three repetitions; the same characters (denoted above), the difference between them was not significant (α = 5%)

Conclusion

Pitaya fruit is important in human diet due to its nutritional value. Substitution of 8% pitaya pulp into wheat dough resulted in the best quality attributes of bread. Pitaya pulp may be supplemented to bread to fortify proteins, carbohydrates and dietary fiber, as well as to improve the texture and flavor of bread. Bread could be stored in OPP/LLDPE pouch for 7 days at ambient condition without any noticeable decomposition in firmness, antioxidant degradation and microbial accumulation. Pitaya pulp utilization would be an alternative as wheat replacement in bakery making with improved nutritional value, functionality, extended stability and minor post-harvest loss of pitaya fruit.

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