Improvement of Bread Characteristics Using By-products from Indian Tropical Fruits

Synopsis submitted

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Chapter 1 (Background of the work) is completely based on review of literature. Through which aim and objectives of the thesis work are prepared. Topic covered in Chapter 1 is 'Dynamic role of natural antioxidant sources on different quality characteristics of bread'. In today's stressful life free radicals are produced continuously in our body. In biological systems, oxidative stress is produced by an imbalance between chemical stress caused by abnormal quantities of reactive oxygen species (ROS) and physical ability to detoxify the reactive intermediates. Oxidative stress if prolonged can damage the entire system and has been implicated in over hundred common diseases such as cancer, diabetes, heart and neurological disorders etc. One of the weapons to combat with this situation is antioxidant.

In this regard natural antioxidants became more popular than synthetic. Numerous studies suggest long term consumption of synthetic antioxidants cause toxic effect like liver damage, cancer etc. Though there is no such effect for natural antioxidants have been found yet. Regular consumption of natural antioxidants has received considerable interest because of their presumed safety and potential nutritional and therapeutic effects. The growing interest in foods rich in antioxidants has led to the development of a large market for natural antioxidant rich products and ingredients.

This trend also stimulated the research on the use of natural antioxidants in bread. According to the literature review different natural antioxidant sources were able to improve the antioxidant activity of the bread samples. Main sources of natural antioxidants include cereals, seeds, spices, herbs, fruits, vegetables and also waste products from the food industry. Enhancement of antioxidant properties mainly depends on the phenolic content of the natural sources and the amount of supplementation. Like, flour samples with low phenolics content are used at up to 20–40% supplementation levels, while spices, herbs and food industry waste with high phenolics content, are added at much lower supplementation levels of 2–10%. For such enrichment process addition level of natural antioxidant sources is an important factor. In most of the studies, with increasing addition level, antioxidant activity was improved. On the contrary the same addition negatively affects texture of the bread, which is a key factor for consumer acceptability. On the other hand several studies show anti-staling effect, antimicrobial effect, improvement in colour and flavour of the bread samples with increasing addition level of antioxidant sources.

So, aim of the study is enrichment of different types of bread by low cost, easily available natural antioxidant source. Yet the existing antioxidant activity of the bread has to improve in such a way, so that overall acceptability of the bread does not affect. Also it has to be studied,

whether this kind of enrichment process is able to improve any physical or sensory characteristics of bread samples along with antioxidant activity.

In this study ripe mango peel of Himsagar variety is used as a source of natural antioxidant. Mango peel was collected by peeling locally available Himsagar mango and ripe mango peel powder (RMPP) was prepared using tray dryer. Through HPLC analysis catechin, dihydroxybenzoic acid, p-coumaric acid and chlorogenic acid were identified as predominant phenolic compounds.

In local market, most easily available whole grain bread is whole wheat bread, which preference to a subject depends on several factors. Some like it due to its health benefits whereas some dislike it for its sensory barriers, intense wheaty, yeasty flavour is one of them. So, the objectives of **Chapter 2** are utilisation of RMPP in whole wheat bread as a natural antioxidant source and evaluation of sensory parameters with an assumption that ripe mango peel may help to improve the flavour of whole wheat bread by its own taste and aroma.

Here both total phenolics content and DPPH inhibition activity were increased gradually with RMPP addition levels. Control bread (without RMPP) showed 21.69% DPPH inhibition, this value increased more than three times at 5% RMPP addition. Sensory parameters were evaluated through descriptive analysis. Both fruity aroma and taste were increased with increasing addition levels of RMPP. On the other side, high phenolics content of RMPP increased the after taste, but as a good sign for 3% and 5% this value was lower than fruity taste. In physical parameters study, % weight loss, loaf height, specific volume was decreased with RMPP addition level. As a result the loaf becomes more dense and hard with compact crumb structure. Fibre present in RMPP helped to increase the moisture content. Both crumb and crust became darker but at higher level between 3% and 5% these values were insignificant. Yet in sensory evaluation for both porosity and crumb colour panellists show an insignificant difference between 1% and 3% samples.

As a conclusion, both antioxidant activity and flavour of the bread samples were improved gradually with the addition levels of RMPP. So, 5% RMPP can be considered as best addition level. But RMPP at 5% showed maximum negative effect on bread texture. Whereas, for selected parameters, an insignificant changes were observed between 1% and 3% samples. Thus, based on the objective, 3% RMPP can be considered as best addition level. As a future scope, modification in processing, especially with the use of bread improvers, may increase the RMPP addition level without affecting bread texture.

In this study (**Chapter 3)** RMPP was used as a source of phenolic compounds in white bread preparation to improve its antioxidant activity. Also RMPP addition level was optimised in respect of both antioxidant activity and physical parameters of the bread samples. Because according to literature review when other fruit by-products were added into white bread by the similar way then besides antioxidant activity improvement it showed a negative effect on physical parameters as well.

Both baking temperature and time were selected as independent variables along with RMPP addition level in a three-level three-factor face-centered central composite design (FCCD) to study their combined effect on specific volume (as a representative of physical parameters**)** and DPPH radical scavenging activity (as a representative of antioxidant activity**).** -1, 0 and +1 levels were 190, 210 and 230 for baking temperature ($^{\circ}$C), 15, 30 and 45 for baking time (min) and 3, 5 and 7 for RMPP addition level (%).

ANOVA results indicate X_3 and X_1*X_2 coefficients have a significant effect on specific volume. Also, significant coefficients for DPPH radical scavenging activity are X_1, X_3, X_1^2, X_3^2, X_1*X_2 and X_2*X_3. The insignificant lacks of fit values for both models indicate the goodness of fit and suitability of the regression model.

According to the graph baking temperature and time showed a negative interaction effect on specific volume. Either high temperature low time or low temperature high time improved the bread specific volume. Besides with RMPP addition specific volume decreased because the fiber and phenolic compounds present in RMPP may weaken the gluten network, as a result bread volume decreased. DPPH radical scavenging activity was significantly affected by RMPP (positive term) and baking temperature (positive term) as linear factors and baking temperature with time (negative term) and RMPP with baking time (positive term) as interaction factors. Optimal processing parameters were determined by Derringer's desired function methodology. A desirability ramp was developed from optimal points via numerical optimisation technique. Baking at 226ºC for 19 min with 7% RMPP was selected as optimal condition with 2.5cm^3/g specific volume and 25.868 µmol AAE/g DPPH radical scavenging activity. Predicted value was confirmed through validation process. Experimental value was in agreement with the predicted values. In comparison with control bread similar overall acceptability was observed for optimised bread. Also optimised bread showed delayed staling than control bread. As a whole this study improves the white bread quality both nutritionally and physically by the utilisation of RMPP.

There is an increasing rate of gluten related disorders in last few years. For example coeliac disease, an immune mediated enteropathy causing inflammation in the small intestine due to the ingestion of gluten. According to the recent epidemiological studies 1 in 100 people worldwide suffer from this disorder. Similarly other gluten related disorders like non coeliac gluten sensitivity, wheat allergy, gluten ataxia, and dermatitis herpetiformis are also increasing day by day. So it became one of our major health concerns now days. As a solution people need to cut the gluten from their diet. Thus consumers become more attracted towards gluten free food.

Gluten, a combination of two proteins gliadin and glutenin, forms during kneading of wheat flour. In baking industry gluten is the key component for viscoelastic property of wheat dough which mainly determine the texture of the final product. In comparison with biscuit and cake its application is higher in bread preparation because the criterion which satisfies the consumers first is volume of the bread loaf. As per literature review, one of the best ways to overcome this limitation is incorporation of dietary fiber in gluten free bread formulation. Dietary fiber increases the elastic property of the batter by forming a film like structure and thus the batter becomes more like dough.

Both raw and ripe mango peel is the major by-product of mango processing industry and is a rich source of natural bioactive compounds that offers potential health benefits. The aim of the study (**Chapter: 4**) was to evaluate flour quality along with the rheology of formulated gluten free dough also physical, antioxidant and sensory properties of the bread samples enriched with equally mixed raw and ripe mango peel powder (MPP) at different levels (2%, 4% and 6%). Flour samples with 4% MPP showed acceptable physical and functional characteristics. In rheology small change was observed for 4% level in comparison with 2% level but a marked increase in visco-elasticity was reported when 4% formulation was compared with control and 6% formulated samples. The phenolic and flavonoid content ranges from (0.18-1.85) mgGAE/g and (0.08-0.14) mgCE/g respectively. The antioxidant activity also increased on increasing level of MPP incorporation. The physical parameters (moisture, height, specific volume, density, crumb hardness, crust and crumb color) showed the best acceptable results on incorporation of 4% level MPP which also satisfies all the sensory attributes and was acceptable by the panelists. Thus, the overall result illustrates the importance of MPP incorporation in the sorghum-rice formulation yielding high antioxidant properties with desired physical and sensory attributes.