

Development of a gluten-free dessert based on starchy plants

Masterthesis at the Department of Agricultural Engineering

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Summary

The objectives of the thesis was to develop a pudding with African flours / starch like plantain, yam and tapioca on the one hand and to develop a method to measure the firmness of pudding that was necessary for the different tests on the other hand. Furthermore it had to be cheap and easy to recreate so that future pudding manufacturers in Africa would be able to use the method.

Several measurement method were tried out. The challenge was to find a method that can measure both thin and firm puddings. None of the common (cheap) methods, that can also be found in literature, were suitable. The author decided to develop a simple method on her own. According to the author's idea the university workshop manufactured rods that have a loop on the top and a welded disk on the bottom. The disk was 3cm in diameter. A simple balance was built using stands and two snatch blocks. A string was passed over the snatch blocks. The freshly cooked puddings was poured into a beaker in which the rod was placed and chilled in the fridge overnight. The pudding beaker then was placed on the left side of the balance and the string was attached to the loop of the rod. Weights were attached to the string on the right side. There were as many weights attached as necessary to pull the rod out of the pudding. This method turned out to be one that was indeed cheap and simple to recreate even under ordinary circumstances.

The standard procedure to cook pudding was to use 500ml of whole milk. 250ml of the milk was heated in a pan with non-stick coating. In the meanwhile the remaining 250ml were mixed with the flour / starch and 40g of sugar. As soon as the milk starts to boil the mix is added and allowed to simmer for (at least) 1 minute under constant stirring. Afterwards the puddings were filled into beakers, cooled down a little and stored in a the fridge overnight. The next day the firmness was measured with the balance.

Test one used different amounts of flour ranging from 20 to 100g per 500ml of milk. Corn starch was used as a reference. Yam and plantain flour pudding behaved similar. Both increased firmness when the quantity of flour used increased. This only

happened up to a certain point. Maximum firmness was reached when 60g of plantain and 60g of yam flour was used. After that point the firmness decreased when more flour was used. This maybe happened due an oversaturation of starch so that a starch-protein network was no longer able to be created. However corn starch pudding increased its firmness as the quantity of flour increased. Tapioca pudding was much weaker, due to starch characteristics. The structure was not creamy but very chewy.

Test two used sucrose, brown cane sugar and honey in different quantities. For each pudding 40, 60 and 80g of sucrose and brown cane sugar was used. Due to the fact that honey contains 20g less carbohydrates than pure sugars 48, 72 and 96g were used. Corn starch pudding remained rather unaffected. The firmness was always between 400 and 600g (weight needed to pull out the rod). Yam and plantain pudding showed no clear pattern when the amount of sucrose and cane sugar decrease or increased. A big change was observed when honey was used (instead of sugar). Honey clearly led to a decline in firmness. The reason for that are amylase enzymes naturally occurring in honey. This enzyme has starch degrading abilities. Tapioca pudding with honey underwent a change. The chewy structure was transferred into a nice and creamy one.

Different fat contents and coconut milk were used in test three. An increase in milk fat due to replace a part of the milk by cream showed no significant increase in firmness. In yam and plantain pudding the firmness was slightly decreased, probably because of the higher fat content as such and the lower protein content which affect the starch-protein network.

Also coconut milk was used instead of cow's milk. When puddings contained 50% coconut milk and 50% water the firmness was much weaker as compared to pudding prepared with 100% coconut milk. This effect is attributed to the coconut oil which is solid under chilled conditions and liquid or semi-solid at room temperature.

To get a rough overview on the acceptability of yam, plantain and tapioca pudding a tasting session was conducted. Nine people from various countries, including Africa, evaluated puddings flavoured with cocoa powder, vanilla flavour, coconut pudding and pure. The clear winner was tapioca honey pudding, also Africans preferred this one. The taste and colour of the other puddings have to be improved in the future.

Finally shelf life tests should give information about the storability. Yam pudding was the worst of puddings prepared with milk. Yam starch is prone to retrogradation which means syneresis occurs only after a short time storage in the fridge. Syneresis means the starch network releases water. This can be seen with the eye. Tapioca starch is not prone to retrogradation. Therefore the author decided to incorporate it in pudding. The results show that tapioca is able to decelerate retrogradation. Tapioca honey pudding showed the best shelf-life. Over the whole period of 10 days there was no change. Pudding on the basis of coconut milk is not recommendable even when tapioca is incorporated. The colour is not appealing and they show a high level of syneresis. The same was done at ambient temperature (20-25°C). Only after two days, the puddings were starting to ferment and a beginning growth of mould was able to be seen on the surface.

Based on the results of all tests, recommendation for pudding recipes can be given: Tapioca pudding contains 40g of starch per 500ml whole milk and 96g honey.

Plantain pudding contains 50g flour per 500ml whole milk, 40g sucrose and 10g of tapioca starch in addition. The firmness can be varied by using more or less flour, but tapioca should make up 20% in plantain pudding to ensure a good shelf life

Yet it is not known how the pudding should taste and look like for consumers of the African market. Therefore a survey should be conducted on-site. Different quantities of sugar, cocoa powder and artificial flavours / colorants can be evaluated for their acceptance.