

Original Research Article

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Edible Bioplastic with Natural pH Indicators

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The rationale of this elementary work was to develop starch based bio-coat for food items using permutation combination of starch of different sources (corn, potato, tapioca) and various plasticizers (glycerine, rice bran oil, sesame oil, castrol oil, soya bean oil and olive oil). An eco-friendly alternative to conventional petro-plastic polymer with a futuristic application as edible food wraps was intended as the outcome. Amalgamation of corn, tapioca and potato starch in even proportions, generated the finest bio-plastic sheet; glycerine was chosen as the ideal plasticizer as vegetable oils yielded brittle bioplastics. Inclusion of red cabbage extract to this bioplastic formulation exhibited colour change with pH variation, a simple panacea for spoilage detection.

Introduction

Packaging is a quintessential entity of today's market having a broad niche covering commodities to food items. Plastic reverberates as the ideal packaging in this new era of modernization; the same also accounts as the most dreaded environmental pollutant because of their sheer lack of degradability. An alternative to this synthetic polymer that features both sustainability and complete degradation is the need of this hour. This has spearheaded the research towards exploring natural polymers; their abundance, availability, non-toxic effect and easy degradation adds on to the appeal and choice for the same as alternative packaging

material. Bioplastics, derived from biological sources either from vegetable stock or microbes is the absolute answer for this scenario (Saharan *et al.*, 2012). The next thing and advancement in the world of packaging is active and intelligent packaging (De John *et al.*, 2005) with former having inherent feature to provide extra protection to the items packed whereas latter is involved in signaling the consumers about the quality of the items packed. Among the advances in intelligent packaging, one of the most interesting and one that renders customers with an ease to assess the freshness visually of the same are colour changing packages. The basis of this

active packaging in changing colour could be triggered change in temperature (thermo chromic materials), irradiation from light (photochromic materials), application of an electric potential (electro chromic materials) or pH change (Lee *et al.*, 2008; Hong *et al.*, 1999). An attempt to develop colour changing bio-plastic with red cabbage extracts to provide a proof of concept that could lead to futuristic development of colour changing bio-wraps or bio-dips for edible items as means for detecting spoilage was attempted here.

Materials and Methods

Standardization of ingredients for bioplastic preparation

The basic ingredients for starch-based bioplastics are starch, vinegar, plasticizer and water. Starch from three different sources; corn, potato and tapioca were procured. A total of 8 trails were conducted; 7 with varying plasticizers and one without any plasticizer (Table 1). Each set entailed of 3 type of starch source and a unique plasticizer. Castor oil, gelatin, glycerol, sesame oil, soya bean oil and olive oil were the array of plasticizers used for the study. For each of these sets, 15gm of each sugar, 5ml of vinegar and 300ml of water were kept constant, only 5ml of plasticizer was varied. For preparing bioplastic, first starch and water were mixed, stirred, followed by heating on a hot plate till the mixture started gelatinizing. After achieving the gelatinization of starch, about 5 ml of plasticizer and vinegar were added. This mixture was placed for 10 min in hot water bath and were spread on an even glass surface with TLC glass spreader adjusted to make thin layer 2mm diameter sheets on a smooth and even surface. These sheets were allowed to dry at room temperature till it was no longer sticking to the surface of layering. After analyzing the quality of plastic based on

their smoothness and elasticity, the best plasticizer was selected. Then next step was to try for the permutation combination of sugars to finalize the best combination for preparation of bioplastic. Equiamount of starch source were weighed for the same keeping the rest constant as mentioned for the previous sets (S-1 to S-8).

Intelligent packing with red cabbage extract

250 gm of the red cabbage was sliced into small pieces and boiled in low heat for 15 min in 500ml distilled water. The extract was filtered and again autoclaved to prevent any fungal growth during the preparation of bioplastics. The best suitable permutation combination was used for this process, the starch components were mixed with 300 ml of red cabbage extract instead of distilled water in a glass vessel. The mixture was heated in a hot plate till the mixture started gelatinizing or melting. After achieving the gelatinization of starch about 5 ml glycerin as plasticizer was added and placed for 10 min in hot water bath following by layering the mixture. The layering was executed with Thin layer plating. The bioplastic thus prepared were cut into equal square slices (1cm x 1cm), two to three drops of citric acid, 0.5N HCl, 2M KOH and 1N NaOH as well as solutions ranging from pH 1 to 14, was added respectively onto each sheets and the colour change was recorded

Results and Discussion

Among 24 combinations tried with singular composition of starch with different plasticizers, only the S-2 series (S-2-1 to S-2-4) gave smooth sheets. The bioplastic sheets (S1 series) without plasticizer were poor and brittle; soft sheets of bioplastics that were easily breakable with even the lightest of pull were produced when gelatin was used as the plasticizer (S3 series).

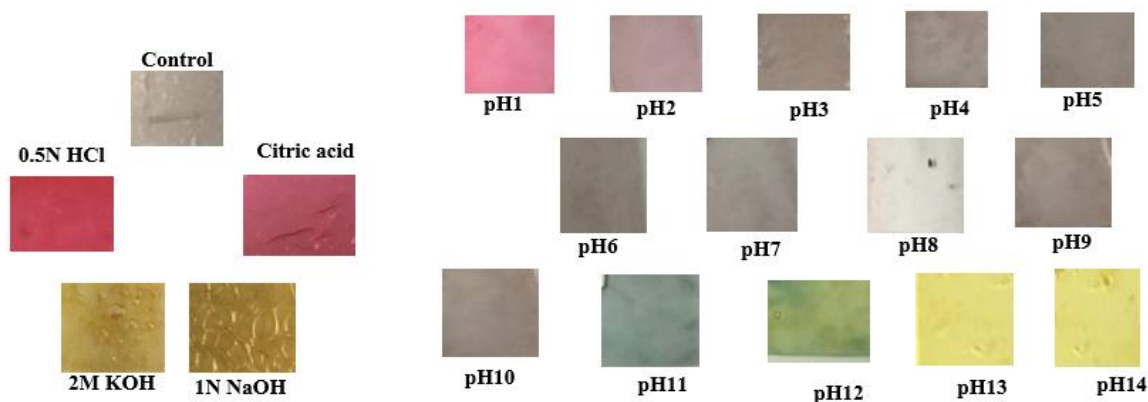
Table.1 Trials of sugar and plasticizer combination

Single sugar (S Series)											
Trial	Starch	Pz	Trial	Starch	Pz	Trial	Starch	Pz	Trial	Starch	Pz
S-1-1	Corn	N	S-3-1	Corn	Ge	S-5-1	Corn	RB	S-7-1	Corn	CA
S-1-2	Potato	N	S-3-2	Potato	Ge	S-5-2	Potato	RB	S-7-2	Potato	CA
S-1-3	Tapioca	N	S-3-3	Tapioca	Ge	S-5-3	Tapioca	RB	S-7-3	Tapioca	CA
S-2-1	Corn	G	S-4-1	Corn	Ol	S-6-1	Corn	SE	S-8-1	Corn	SO
S-2-2	Potato	G	S-4-2	Potato	Ol	S-6-2	Potato	SE	S-8-2	Potato	SO
S-2-3	Tapioca	G	S-4-3	Tapioca	Ol	S-6-3	Tapioca	SE	S-8-3	Tapioca	SO
Combination (D series)											
D 1	Corn+Potato			D2	Corn+Tapioca			D3	Tapioca+Corn		
D4	Tapioca+Potato			D5	Corn+ potato+Tapioca						

Starch of different source and grade were procured; Corn, starch and extra pure starch from Chemical International, Mumbai whereas potato and tapioca starch from SRL and Plantain banana powder (Bana rich, Cochin Ayurvedic center). Among the different plasticizer tried, glycerine was obtained from Chemical International; s well as red cabbage (the source of pH indication) where procured from local groceries store.

Plasticizer: Pz; N: nothing was added; G: Glycerol; Ge: gelatin; Ol: Olive oil; RB: Rice Bran oil; SE: Sesame Oil, CA: Castor Oil; SO: Soya bean oil

Fig.1 Colour change observed in bio-plastic with red cabbage extracts



Sheets turned to be hard, shapeless and brittle in all the trials where vegetable oil (S4 to S8 series) was used as plasticizer. Glycerol was found to be the ideal plasticizer, providing stretchable, smooth, transparent and good quality bioplastics. Potato starch plastics appeared the most clearest or transparent followed by corn, and tapioca. All the D series showed smooth transparent bioplastics but the steadiest yet stretchable and wrap-able quality were given by D5 (all sugars) followed by D4 (combination of tapioca and potato). Subsequently D5 combination with red cabbage extracts showed visible colour change. Red cabbage extract comprise of

anthocyanin, natural water soluble pH indicators that give reddish pink to violet colour in acidic conditions (pH 1-6) whereas in basic or alkaline condition (pH 8-14) colour change from blue to green and finally and to yellow at extreme alkaline condition (Chigurupati *et al.*, 2002). In the current study the change in colour was observed [Fig 1] in extreme acidic (till pH 2) and alkaline conditions (pH 11-14). Increase in concentration of red cabbage extracts in the bioplastic preparation can help in defining the pH variability with much clarity, nevertheless the colour change observed here proved that the bioplastics coupled with these natural pH

indicator has applicability. This proves as a simple and smart method of signaling consumers the quality of the food that is dependent of pH change.

References

- Brockgreitens, J., Abdenmour, A. 2016. Responsive Food Packaging: Recent Progress and Technological Prospects. *Comprehensive Rev. Food Sci. Food Safety*, 15(1): 3-15, DOI: 10.1111/1541-4337.12174.
- Chigurupati, N., Saiki, L., Gayser, C., Dash, A.K. 2002. Evaluation of red cabbage dye as a potential natural color for pharmaceutical use. *Int. J. Pharmacol.*, 241(2): 293-299.
- De Johng, A.R., Boumans, H., Slaghek, T., Van Veen, J., Rijk, R., Van Zandvoort, M. 2005. Active and intelligent packaging for food: Is it the future? *Food Additives and Contaminants*, 22(10): 975 – 979.
- Hong, S.I., Park, W.S. 1999. Development of color indicators for kimchi packaging. *J. Food Sci.*, 64: 255-257.
- Lee, D.S., Yam, K.L., Piergiovanni, L. 2008. *Food Packaging Sci. Technol.*, Boca Raton, FL: Taylor and Francis Group., pp. 445- 473.
- Saharan, B.S., Sharma, D. 2012. Bioplastics- For Sustainable Development: A Review. *Int. J. Microbial Res. Technol.*, 1(1): 11-23.

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