Effect of Coating Pelleted Animal Feed with Novel Edible Coating Mixture

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Abstract— *This current study was undertaken to evaluate the effect of combining Aloe vera gel and African star Apple (Chrysophyllum albidum) juice on the shelf life and physical appearance of pelleted animal feed. The extracts of these two plants were prepared using standard methods and applied by spray pyrolysis method on the feed. The two extracts were proportionally mixed using the optimal design of mixture method. The optimal proportion was 4:1 (Aloe vera gel to African star apple juice). The phytochemical analysis of both extracts was carried out and found to contain kaempferol, flavanone, tannin, phylate, and aphylidine which are very effective antimicrobial and antioxidant agents. The toxicity test (LD50) shows that the blend of both extracts was non-toxic. This result was buttressed by FTIR analysis which showed no harmful functional group. The resultant effect of coating feed pellets with this novel mixture was an extension of the shelf life of pellets by 14 days and improving the physical appearance of the feed.*

Keywords— Edible coating, Aloe vera, African star apple, shelf-life, Pelleted feed.

I. INTRODUCTION

Prolonging the shelf life of perishable food products is currently a major challenge. Food preservation technologies and edible film and coating seem to be the solution. The uses of edible films and coatings developed from food biopolymers have advanced significantly during the last few years. (Panchal et al., 2022).

The rising consumer concerns about food quality and health benefits compel researchers to find a way to enhance food quality while not disturbing the product's nutritional value. The demand for plant-based materials has been increased in the food industry as many of them contain essential elements and also found to be an eco-friendly material (Pham et al., 2023).

Applying a thin layer of edible coating made from protein and lipids can inhibit the product from decay and extend the shelf life. They serve as gas and moisture inhibitors which regulate the respiration rate, slowing down the ripening of vegetables. Antimicrobial agents, enzymes, minerals, and vitamins are also used in edible coatings, which boost practical properties. ("Edible Films and Coatings for Food Applications," 2009a). Edible coatings have become popular in the food industry because they produce less waste, are cost-effective, and offer protection after the package has been opened (Kundu et al., 2020).

The preservation of taste and extension of shelf-life of animals and other agro-products have been of major concern to many farmers (Agarwal & Saini, 2016).

Edible coating could be made from various substances both natural and synthetic, and their ability to serve in elongating the shelf life and retention of texture is of paramount importance. Yossef, M.A (2014) compared 4 different edible coating materials (pectin, gluten, starch, and protein) applied on the surface of fruits. Fruit quality was evaluated by weight loss, firmness retention, visible decay, surface color development, titratable acidity, total soluble solids, reducing sugars, and sensory attributes. The pectin-based coating had a significant effect on the retention of firmness, reduced weight loss, and showed better results from the Physico-chemical analysis compared to the other coatings and to the control fruit (O & Author, n.d.).

1.1 Aloe vera:

Aloe vera gel has recently drawn interest as a potential edible coating substance in the food industry. Aloe vera-based edible coatings prevent moisture loss and keep fruits firm, control respiration rate, delay oxidative browning, and reduce microorganism proliferation in sweet cherry, table grapes, and nectarines (Misir et al., 2014).

Polysaccharides, glycoproteins, phenolic compounds, salicylic acid, lignins, hormones, amino acids, vitamins, saponins, and enzymes are just a few of the complex ingredients that give aloe vera its wide range of beneficial properties. Gel made from aloe vera has antibacterial, antifungal, and anti-inflammatory properties. Aloe vera gel is primarily used in the cosmetics sector to treat burns, and scars, and to promote wound healing (Padmaja et al., 2015)(Singh et al., n.d.).

With the growing consciousness of the bad effects of various chemical techniques and environmental hazards emphasize a need to develop consumer-friendly and environment-friendly technology to increase the shelf life of mango fruits while maintaining their quality and general acceptability. The use of edible coating is becoming popular because it is hazard-free and environmentally ("Edible Films and Coatings for Food Applications," 2009b).

In a related study, (Suriati et al., 2018) reported the efficacy of Aloe vera gel as a source of cost-effective and eco-friendly packing material for tropical and subtropical fruits. It was found to extend the shelf life of figs by delaying decay and ripening as reflected in lower weight loss, lesser changes in physico-chemical parameters, greater firmness, better sensory quality, and marketability.

African Star Apple botanically called Chrysophllum Albidum and known in Igbo as Udara is a yellowish round tropical fruit. It is found mostly in Southeast and Southwest Nigeria. It is a seasonal fruit and is available in abundance from December to March annually. The fruit has four or five seeds and when ripe is sweet but tastes sour when unripe(Phytochemical Constituent of African Star Apple, n.d.).

Pelletization is the act of compressing and molding materials into pellets (Deb & Ahmed, 2016). Pellets could be produced in different sizes depending on the area of application. In recent years, pelletization has gained increasing interest among researchers due to its relative advantages over other similar industrial techniques. It is widely used in pharmaceutical, ore processing, animal feed, and fertilizer industries. Pellets are simple small free-flowing spherical particles formed by the agglomeration of fine powder of Phytochemical Constituent of African Star Apple (n.d.)granules. The mean diameter of pellets ranges from 3.0-9.0 mm.

With screw extrusion palletization, the pellets maintain all the active ingredients, and feed wastage is reduced to the barest minimum. Pelletization of animal feed facilitates the storage and transportation of the feed (Tashiwa et al., 2019). It also reduces selective Feeding.2.0mm.(Barkate et al., 2020) Among the various production methods of fish feed, screw extrusion. The edible films are differentiated from coatings by being a standalone material, whereas the coatings are directly applied to the food surface. The edible coatings hold the same properties as the films ("Edible Films and Coatings for Food Applications," 2009c) (Raghav et al., 2016).

II. MATERIALS AND METHOD

TABLE 1

S. No.	Material	Description
1	**P**elleted feed	Cylindrical-shaped brownish extrudate
2	**Aloe vera**	Shrubby or arborescent, perennial, xerophytic, succulent, pea-green colour plant
	(Aloe barbadensis)	
3	African star apple	Wild plant with sweet pleasantly acidic, fleshly fruit pulp
	(Chrysophyllum albidum)	

The pellets were produced using a single screw horizontal pelleting machine powered by a 5 hp electric motor.

Preparation of edible coating. The aloe vera and African star apple were thoroughly washed with chlorinated water and rinsed with distilled water. The back of the aloe vera leaf was peeled and the pulp was crushed and squeezed extracting the gel. While the African star apple seeds were extracted, the yellowish pulp was compressed and the juice was extracted. An optimal mixture design of the experiment was applied and the optimal mixture ratio was derived. 2.0g/L of Ascorbic acid and 4.5g/L OF citric acid were added to the mixture. Water served as the universal solvent.

Phytochemical analyses of both Aloe vera and African star apple were carried out to determine the active phytochemical composition of each plant. Also, a toxicology analysis using the LD_{50} method was equally carried out. Results were recorded accordingly.

Method of application of edible coating. A spray pyrolysis technique was adopted in coating the pellets.

III. RESULTS AND DISCUSSION

3.1 Optimal Mixture design:

The edible coating is composed of Aloe vera gel, African star apple juice, and water which are the major constituents. The appropriate quantities of Aloe vera gel, African star apple juice, and water used for compounding the edible coating were optimized using Optimal mixture design. The results were analyzed with Design Expert software. A ratio of 4:1 was derived and used in constituting the edible coating.

3.2 Graphical Optimization:

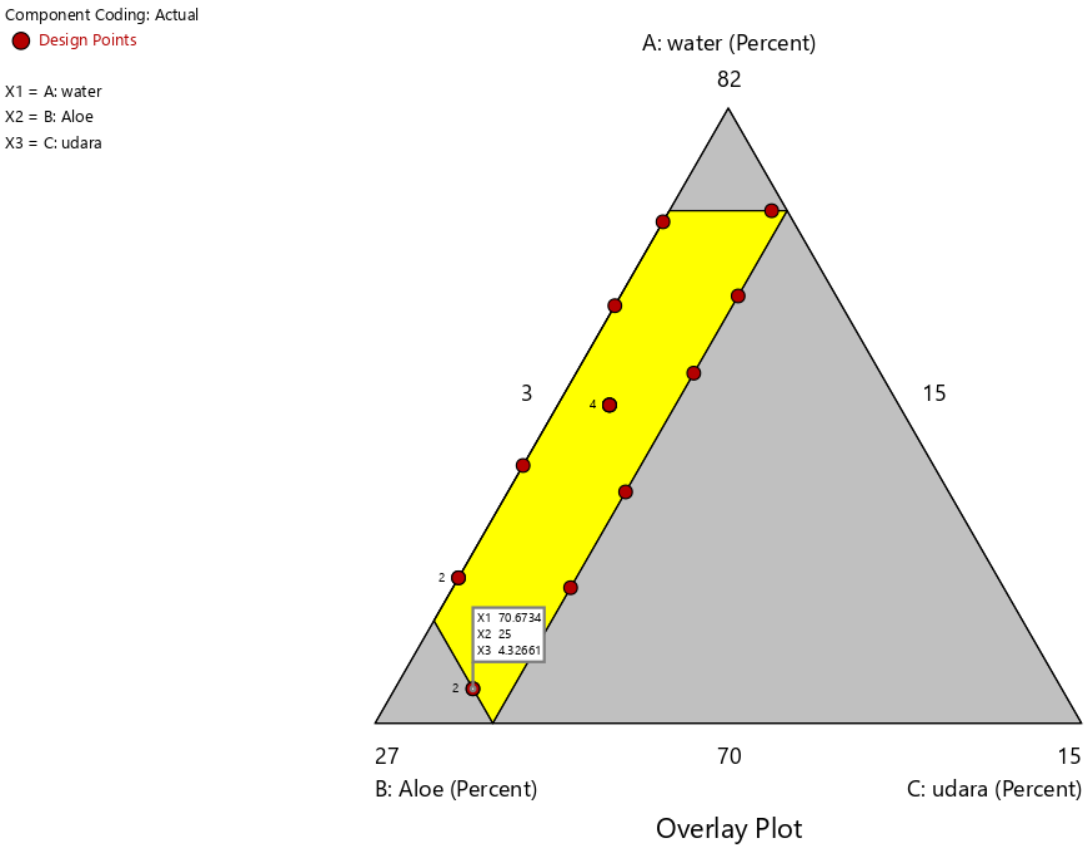

FIGURE 1: Graphical Optimization of Mixture Components.

The trapezium with the triangular defines the estimated values for the different combinations of the mixture components. The optimal values of the mixture components are the same as those generated by the numerical optimization plots. These values are still 70.7% water, 25% Aloe vera gel and 4.3% African star apple juice.

3.3 Phytochemical analysis:

Active phytochemicals in Aloe vera are of Aloe vera of African star apple.

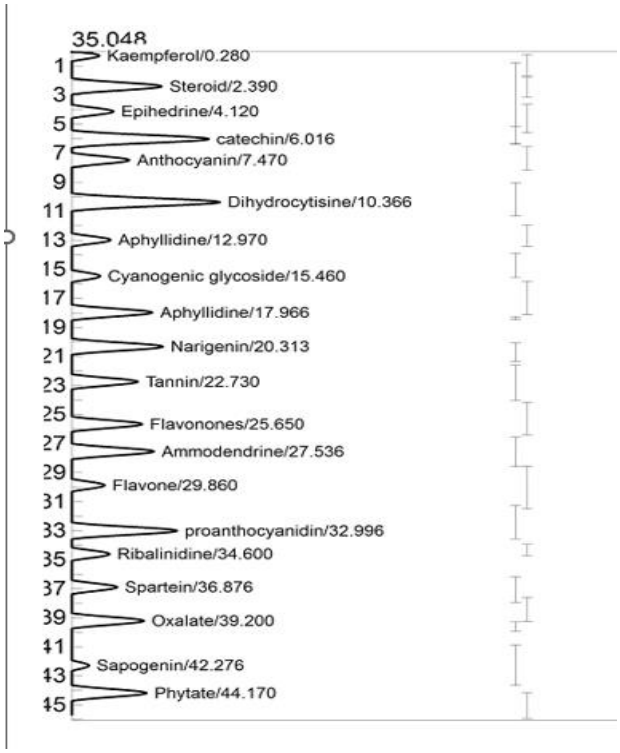

FIGURE 2: Spectral display of phytochemical of Aloe vera

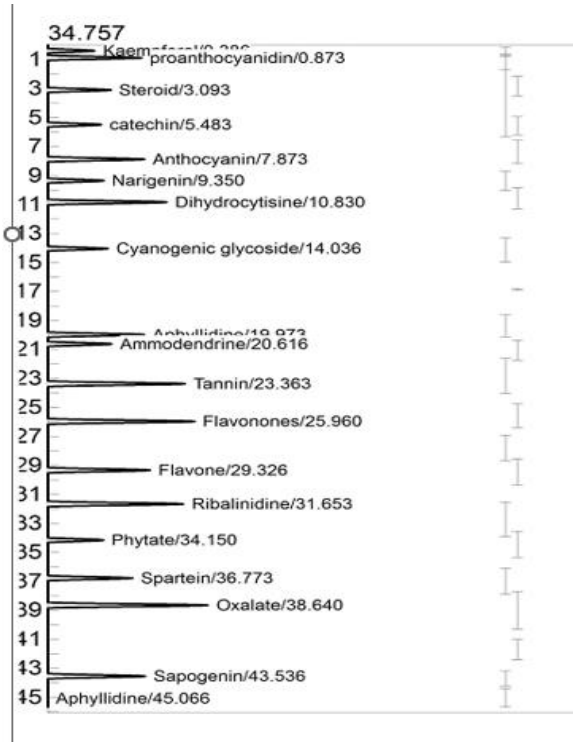

FIGURE 3: Spectra display of phytochemicals of African star apple

Figure 2 shows that aloe vera contains 44.170Ug/ml of phylate which is the most dominant phytochemical in aloe vera. Study results have shown that phylate has beneficial health effects such as antioxidant and anticancer potential and reduction in pathogenic disorders. Next in the order of abundance is sapogenin 42.276Ug/ml. Sapogenin is known for its antimicrobial effect. The phytochemicals of the African Star Apple were determined quantitatively by Springbod laboratory, Awka, Anambra state. As seen in Figure 3, Aphylidine has the highest retention value of 45.066 Ug/ml. Quantitative analysis of phytochemicals in African star apples shows the presence of kaempferol, steroid, catechin, tannin, flavanones, flavone, oxalate, and aphylidinein reasonable quantities. These are effective antimicrobial and antioxidant agents.

IV. CONCLUSION

The blend of Aloe vera gel and African star apple juice has proved to be a very effective edible coating mixture. The shelf life of pelleted feed was extended by 14 days as the novel mixture acted as an antimicrobial and antioxidant agent. A visible improvement in the physical appearance of the pellet was recorded. The outcome of this research work could be extended to the preservation of other perishable agro-products and subsequent reduction in post-harvest losses.

REFERENCES

[1] Agarwal, N., & Saini, M. (2016). EDIBLE COATING OF FRUITS AND VEGETABLES: A REVIEW. https://www.researchgate.net/publication/331298687

[2] Barkate, A. R., Bothara, S. B., Mahaparale, P. R., Lohar, P. S., &Tambade, S. B. (2020). Methods of Pelletization Using Extrusion – Spheronization: A Review. International Journal of Pharmacy and Pharmaceutical Research, 18(1), 385–399. https://doi.org/10.25166/ijppr.2020.v18i01.029

[3] Deb, R., & Ahmed, A. B. (2016). PELLETS AND PELLETIZATION TECHNIQUES: A CRITICAL REVIEW. International Research Journal of Pharmacy, 4(4), 90–95. https://doi.org/10.7897/2230-8407.04414

[4] Edible Films and Coatings for Food Applications. (2009a). In Edible Films and Coatings for Food Applications. Springer New York. https://doi.org/10.1007/978-0-387-92824-1

[5] Edible Films and Coatings for Food Applications. (2009b). In Edible Films and Coatings for Food Applications. Springer New York. https://doi.org/10.1007/978-0-387-92824-1

[6] Edible Films and Coatings for Food Applications. (2009c). In Edible Films and Coatings for Food Applications. Springer New York. https://doi.org/10.1007/978-0-387-92824-1

[7] Kundu, P., Adhikary, N. K., & Maji, S. (2020). A Critical Review on Use of Edible Coating to Enhance Shelf Life of Mango. Current Journal of Applied Science and Technology, 116–128. https://doi.org/10.9734/cjast/2020/v39i2730926

[8] Misir, J., H. Brishti, F., & M. Hoque, M. (2014). Aloe vera gel as a Novel Edible Coating for Fresh Fruits: A Review. American Journal of Food Science and Technology, 2(3), 93–97. https://doi.org/10.12691/ajfst-2-3-3

[9] O, A. C., & Author, C. (n.d.). Effect Of Chitosan Coating Combined Aloe Vera Gel On Cucumber (Cucumis Sativa L.) Post-Harvest Quality during Ambient Storage. Journal of Emerging Trends in Engineering and Applied Sciences (JETEAS), 6, 5. https://www.researchgate.net/publication/301803607

[10] Padmaja, N., Don Bosco, S. J., & Rao, J. S. (2015). Physico Chemical Analysis of Sapota (Manilkara zapota) Coated by Edible Aloe Vera Gel. International Journal of Applied Sciences and Biotechnology, 3(1), 20–25. https://doi.org/10.3126/ijasbt.v3i1.11703

[11] Panchal, N., Das, K., Prabhakar, P. K., &Ghanghas, N. (2022). Edible Films and Coatings for Fruits and Vegetables: Composition, Functions, and Regulatory Aspects. In Edible Food Packaging (pp. 191–216). Springer Nature Singapore. https://doi.org/10.1007/978-981-16-2383-7_10

[12] Pham, T. T., Nguyen, L. L. P., Dam, M. S., & Baranyai, L. (2023). Application of Edible Coating in Extension of Fruit Shelf Life: Review. AgriEngineering, 5(1), 520–536. https://doi.org/10.3390/agriengineering5010034

[13] Phytochemical constituent of African star Apple. (n.d.).