

# Food Waste Valorization Through Green Synthesis of Silver Nanoparticles in Bakery Products: Effect on Physicochemical and Nutritional Properties

Syeda Fatima Noor\*, Muhammad Arsalan Mahmood

Food Science and technology, Jinnah University for women, Pakistan

\*E-mail: syedafood@gmail.com

## ABSTRACT

---

Pomegranate peel as a bio-waste is a source of environmental pollution. It is rich in various polyphenols, among them tannins and anthocyanins are in abundance. The peel is a rich source of hydrolysable tannins. Punicalagin accounts for 85% of total tannins. Punicalagin is the precursor of Urolithin, which is a metabolite resulting from transformation of ellagitannins by gut bacteria i.e. *Gordonibacterurolithinifaciens* etc. Studies found that urolithin exhibits immunomodulatory, anti-inflammatory, antimicrobial, antioxidant, neuroprotective and anticancer properties. This study focuses on the incorporation of urolithin precursor and urolithin nanoparticles in cupcakes, its effect on physicochemical, dough rheology and nutritional properties of cupcakes which may help in the treatment of dementia/Alzheimer's disease, Parkinson's disease and certain cancers (prostate and colon) etc. Nanotechnology will be used to make silver nanoparticles of urolithins which are then incorporated in cupcakes. Four samples will be studied as, punicalagin cupcakes (PuCc), punicalagin nanoparticle (PuNCc) urolithin cupcakes (UroCc), urolithin nanoparticle cupcakes (UroNCc) along with control. Farinograph, and viscoamylograph tests will be used to measure rheological parameters of the dough after punicalagin, urolithin and their nanoparticles incorporation. All the samples will be compared to select the best suitable compound and its incorporation in the cupcakes and for further industrial application.

**Keywords:** Cupcakes, nanoparticles, pomegranate peel, punicalagin, rheological properties, urolithin

---

## INTRODUCTION

The use of food waste or by-products into the value addition of products that gives back to food supply chain is known as 'food waste valorization'. (Food waste valorization, 2021).

Pomegranate (*Punicagranatum*) is one of the ancient fruits, known for its therapeutic effects and used extensively in traditional medicine. However, most of its benefits lost as a waste in the form of pomegranate seed and peel. Ellagitannins (ET) are the main bioactive components in pomegranate peels, largely represented by punicalagin, a type of phenolic compound particular to pomegranate. ET exhibits anti-microbial, anti-inflammatory, antioxidant and anti-cancer properties. (Belgacem *et al.*, 2021).

Gut bacteria produce 'urolithin'in humans when get exposed to ellagic acid (EA) and ellagitannins (ET) like punicalagin. These precursors are present extensively in pomegranate, walnuts and pecans. ET get transformed to EA in the gut, and then metabolized by stomach microflora into urolithins. Urolithin production differs largely among individuals due to variations in the gut microbiome. Urolithins are excreted in urine and feces after absorption (Singh *et al.*, 2021).

Nanoparticles are a kind of colloidal drug transporting system which involves particles in size range of 10 to 1000 nm in diameter. Main benefits of nanoparticles include improved bioavailability by increasing aqueous solubility, expanding residence time in the body (expanding half-life for clearance/expanding specificity for its related receptors) and directing drug to discrete location in the body (action site). This results in reduced amount of drug required and dose toxicity and prevention of non-target cells from serious after effect. This is of great interest as they have the potential to cross organ barriers like blood brain barrier, membrane of cell etc. (Sagar, 2011).

Cake is one of the most common bakery items. Standard characteristics of cake depend on a lot of elements, including the ingredients of cake batter, the extent of aeration, and the mixing/baking process. In the proposed study, cupcakes will be considered to be a fitting substitute of nutraceutical food for the utilization of PPs (Conforti, 2006).

## METHODS

Different extracts will be made by using the method described by Dahham *et al.*, (2010). The nanoparticles of punicalagin and urolithin will be biosynthesized and characterized by using the method described by Esawyet *et al.*, (2019). The cupcakes will be made according to the method described by AACC (2002).

To determine the rheological properties of cupcake dough, farinograph and viscoamylograph equipment will be used by following the method of AACC (1987).

The total phenolic contents of dough and cupcakes will be determined by the method of Esawyet *et al.*, (2019). Nutritional analysis includes the composition of wheat flour, dough and cupcakes will be determined by AWRC (alkaline water retention capacity), SRC (solvent retention capacity) and a kernelyzer machine. Radical scavenging activity of dough and cupcakes will be determined by the technique described by Abdallah *et al.*, (2017).

The dimensional properties of cupcakes like volume, weight, height, density, and diameter will be measured using vernier caliper, RD (relative density) bottle and weight balance. The crumb and crust colors of the cupcakes will be studied using a colorimeter, according to the CIE L\* a\* b\* scale, described by hasmadi *et al.*, (2018).

The cupcake texture will be determined by using the method of hasmadi *et al.*, (2018). To evaluate the microstructure of dough, cupcakes and nanoparticles, SEM (scanning electron microscope) will be used according to the method of Urganci and Isik (2021). The sensory evaluation of cupcakes will be determined by following the method of (AACC, 1994).

All experiments will be performed in triplicate. All the results will be statistically analyzed by the method of Ali and Bhaskar (2016).

## CONCLUSION/ FUTURE PROSPECTS

The proposed study may suggest the use of bioactive components of pomegranate peel for disease treatment using bakery products. This study floats the idea of setting up small baking industries without the need of huge investment, and will help in boosting the national economy. Thus, creating more job opportunities for young food technologists. Moreover, the application of this research will provide the opportunity to utilize food waste that otherwise will cause pollution. However, evaluation of toxic components of pomegranate peel or side effects needs to be conducted in future for its safe use in food applications, as a supplement or drug.

## REFERENCES

1. Singh A, D'Amico D, Andreux PA, Dunngalvin G, Kern T, Blanco-Bose W, Auwerx J, Aebischer P, Rinsch C. (2021). Direct supplementation with Urolithin A overcomes limitations of dietary exposure and gut microbiome variability in healthy adults to achieve consistent levels across the population. *Eur J Clin Nutr.*
2. Sagar R. M.; Amol B. D.; Sachin P.; Chetan M. B. (2011). Nanoparticles: Emerging carriers for drug delivery. , 19(3), 0–141.
3. Belgacem, I, Li Destri N, M.G. Pangallo, S. Abdelfattah, A. Benuzzi, M. Agosteo, G.E. Schena, L. (2021). Pomegranate Peel Extracts as Safe Natural Treatments to Control Plant Diseases and Increase the Shelf life and Safety of Fresh Fruits and vegetables. *Plants*, 10, 453. <https://doi.org/10.3390/plants10030453>.
4. Dahham S.S., Ali M.N., Tabassum H., and Khan M. (2010). Studied on antibacterial and antifungal activity of pomegranate (*Punicagranatum*L.). *American-Eurasian Journal of Agricultural & Environmental Sciences*, vol.9, no.3, pp.273281,.
5. Esawy, Mona A.; Ragab, Tamer I. M.; Shalaby, All Shimaa G.; Basha, Mona; Emam, Mahmoud (2019). Evaluated bioactive component extracted from *Punicagranatum* peel and its Age NPs forms as mouthwash against dental plaque. *Biocatalysis and Agricultural Biotechnology*, 18(), 101073–. doi:10.1016/j.bcab.2019.101073.
6. AACC (2002). *Approved Methods of the American Association of Cereal Chemists*. Ame. Assoc. Cereal Chem., St. Paul.
7. AACC (1987). *Approved Methods of the American Association of Cereal Chemists*. Published by American Association of Cereal Chemists, Ins. St. Paul, Minnesota, U.S. A.
8. AACC (1994). *Approved Methods of the American Association of Cereal Chemists*. Ame. Assoc. Cereal Chem., St. Paul. Minnesota, U.S.A
9. Hasmadi M. Jahrul Md. Haque A., Zainol k. M. & Yu A. L. (2018). The Influence of Seaweed Composite Flour on the Physicochemical Properties of Muffin, *Journal of Aquatic Food Product Technology*. <https://doi.org/10.1080/10498850.2018.1468841>.
10. Ali Z, Bhaskar SB. (2016). Basic statistical tools in research and data analysis. *Indian J Anaesth.* 2016;60:662-9.
11. Urganci U., Isik F. (2021). Quality Characteristics of Biscuits Fortified with Pomegranate Peel. *Akademik Gıda* 19(1) (2021) 10-20, DOI: 10.24323/akademik-gida.927462.
12. Sharayei, P., Azarpazhooh, E. & Ramaswamy, H.S. (2020). Effect of microencapsulation on antioxidant and antifungal properties of aqueous extract of pomegranate peel. *J Food Sci Technol.* 57, 723-733.
13. Dina A. A., Abd El-Mageed M.R., Siliha H.A. and Rabies M.A. (2017). Physicochemical characteristics of persimmon puree and its utilization in cupcakes. *Zagazig J. Agric. Res.*, Vol. 44 No. (6B). 2629-2640.
14. Food waste valorization. (n.d.). National Environment Agency. <https://www.nea.gov.sg/our-services/waste-management/3r-programmes-and-resources/food-waste-management/food-waste-valorisation>.
15. Conforti, F. D. (2006). Cake manufacture. *Bakery products: Science and technology* (pp. 393–411).