

Chapter 7

Conclusions and future scope

7.1 Conclusions

- The disparity in physicochemical and functional properties of *Euryale ferox* kernel starch could be related to varietal difference, level of maturity, environmental and climatic conditions.
- The pasting and thermal properties revealed that product made with *Euryale ferox* kernel starch will be less viscous, stable under severe processing conditions and have a high resistance against retrogradation.
- The high amounts of starch present in the seed and their functional properties, *Euryale ferox* may be consider a potential alternative source of starch.
- *Euryale ferox* kernel starch complex may be utilized as a filler material for biodegradable packaging films, as well as for flavor encapsulating matrix because of it remarkably small granule size.
- *Euryale ferox* shell is an attractive raw material for polyphenols extraction and recovery. Gallic acid, ferulic acid, quercetin, caffeic acid, catechin, rutin and ellagic acid were detected as major components.
- The solid: solvent ratio had an impact on the phytochemical composition, including its phenolic and flavonoid content, as well as antioxidant capacity, and the best results were obtained with 1: 50 w/v MAE.
- *Euryale ferox* seed shell extract was found to possessed potent antioxidant activity.
- *Euryale ferox* seed shell extract inhibited α -glucosidase more efficiently than acarbose, thus could be utilized as a natural ingredient to regulate postprandial blood sugar level.
- The MTT assay revealed that the *Euryale ferox* seed shell extract had no negative impact on the viability of L6 skeletal muscle cell line and THP-1 human cell line.
- *Euryale ferox* seed shell extract enhance the glucose uptake in L6 muscle cells.
- *Euryale ferox* seed shell extract showed strong inhibitory activity against DPP-IV enzymes.
- *Euryale ferox* seed shell extract is an effective inhibitor for inflammatory mediators, such as pro-inflammatory cytokines viz., IL-1 β , IL-34, TNF α , IL-23, IL-6, and Cox-2. These findings suggested that *Euryale ferox* seed shell extract may be utilized as

a novel therapeutic alternative for the management of inflammatory-based chronic illnesses.

- Starch-polyphenol complex was prepared by pre-gelatinization method.
- XRD, FTIR, ¹H NMR, and DSC confirmed the appearance of an intermolecular connection between *Euryale ferox* kernel starch and polyphenols, complexes was likely driven by non-covalent intermolecular hydrogen bonds.
- The starch-polyphenols complexes' XRD results showed that the native starch's crystal structure had vanished and that new crystalline areas had developed.
- The ¹H NMR spectra of starch-polyphenols complexes showed multiple additional peaks between 6.00- 9.00 ppm due to the benzene ring and phenolic hydroxyl groups imparted from polyphenols.
- The shifting and widening of the characteristic peak observed in the DSC thermogram confirmed that polyphenols were successfully attached to starch.
- The starch hydrolysis rate (%) of the complexes was reduced, transforming digestible starch to resistant starch and exhibiting low pGI.
- The combined effects of the reordered structure of the complexes and the suppressing activity of polyphenols opposed to starch digestive enzymes.
- The complexation produced pronounced antioxidant capability to the complex.
- Addition of polyphenols altered the granule morphology, swelling capacity, and the solubility of the complexes, and were governed by variations in the types and levels of phenolic compounds.
- Fortification of bread with *Euryale ferox* seed shell extract affect loaf volume, hardness, and color.
- The swarm intelligence supervised neural network (SISNN) approach was much better as compared to mathematical modelling for the predictive simulation of digestion kinetics and pGI
- Further, *Euryale ferox* seed shell extract may be utilized as a curative ingredient that can be used to develop lower glycemic index healthy bread.

- The replacement of gluten-free flour mix with *Euryale ferox* kernel starch-*Euryale ferox* seed shell extract complex could significantly reduce the starch digestion rate of the bread, their glycemic index, and enhanced the antioxidant activity.

7.2 Future scope of the present investigation

- The current research work presents the characteristics of *Euryale ferox* kernel starch, bioactivities of *Euryale ferox* seed shell extract including antioxidant, anti-diabetic and anti-inflammatory properties. Further, the development and characterization of starch-polyphenols complex from *Euryale ferox* seed is also presented. The developed complex was found to be rich in antioxidant, high resistant starch and low pGI. *Euryale ferox* seed shell extract and the starch-polyphenols complex were incorporated in wheat-based bread and gluten free bread respectively.
- *In vivo* studies may be conducted for the anti-diabetic and anti-inflammatory properties of the *Euryale ferox* seed shell extract.
- Starch-polyphenols complex may be prepared by using emerging techniques such as high-pressure homogenization, mechanical activation, and combine ultrasound-microwave treatment etc.
- The potential of starch-polyphenols complexes may also be studied for its effective delivery after incorporation in functional foods.
- Starch-polyphenols complexes could be used as a potential prebiotic in the formulation of functional foods.