CHAPTER IV
SUMMARY AND CONCLUSION

SUMMARY

Pomegranate is an important part of the diet in certain parts of the world. The edible parts of pomegranate fruits are consumed fresh or used for the preparation of fresh juice, canned beverages, wines, jelly, jam, and paste and also for flavoring and coloring beverage products. Pomegranate fruit are rich sources of proteins, vitamins, minerals and having wider application in medicine both in Ayurvedic and Unani system.

Recent scientific findings corroborate traditional usage of the pomegranate as a medical remedy and indicate that pomegranate tissues of the fruit, flowers, bark, and leaves contain bioactive phytochemicals that are antimicrobial, reduce blood pressure and act against serious diseases such as diabetes and cancer. The research interest on pomegranate fruit is increased as a consequence of reports establishing its benefits on human health. In this respect, Pomegranates have been studied as protective means of the cardiovascular system, the treatment of the acquired immune deficiency syndrome, in hormone replacement therapy, in oral hygiene.

India is one of the largest producers of pomegranate in the world. During 2016-17, pomegranate was cultivated over 1.31 lakh ha with an annual production of 2242 Millian tonnes and productivity of 12 MT.ha$^{-1}$ in India. Gujarat ranks third in pomegranate production after Maharashtra and Karnataka with Kutch and Banaskantha as the leading districts. Ganesh, Mridula, Ruby, Arakta and Bhagwa are some of the important varieties of pomegranate grown in India.

The pomegranate fruit is divided into arils (composed by juice and seeds) and peels which include the interior network of membranes. Pomegranate juice is the greatest contributor for pomegranate ingestion which contains 85% water, 10% total sugars, 1.5% pectin, ascorbic acid, and polyphenols. Pomegranate contains 48 to 52 per cent of edible part on the whole fruit basis, which comprises of 78% juice and 22% seed. On whole fruit basis the juice yield is about 50% while on aril weight basis...
yield is about 76 to 85%. Because of its high nutritive value, therapeutic properties, antioxidant capacity, potentially bioactive compounds and consumer appeal, pomegranate is considered as a ‘Superfruit’ and a food medicine.

In India, in spite of the known nutraceutical benefits and great global demand for potentially pomegranate derived products; the pomegranate processing industry is not developed due to lack of technological developments for commercialization and unavailability of scientific research database. In spite of these facts, farmers having post harvest losses is very high about 20-40% in their production, and 10-15% in fresh produce reduce their market value and consumer acceptability due to improper postharvest management.

The pomegranate fruit is abundant in the production season and always very scare and expansive during the off season. The attempt to store fruit in its fresh and natural form has failed due to lack of effective storage and preservation methods. Processing this fruit into value added products such as canned beverages, juice, wines, jelly, jam, and paste etc. is an alternate which make it possible to make it available throughout the year and to earn potential revenue for the producers.

However, juice is better way of storage, preservation However, juice is better way of storage, preservation and value addition. The foremost challenge in juice extraction is the peeling of the fruit, as it is time consuming and irritating as the hands get stained due to polyphenols and oxidative enzymes contain in peel. The lack of low cost and efficient means or adequate processing techniques to quickly process the fruit, poor marketing and transport system as well as fruit perishability contribute more post harvest losses of the fruit production.

The basic method for extraction of juice involves the cut opening of the fruit, seed separation and pressing in screw press or basket press. In another method, the fruits are quartered and crushed or the whole fruits may be pressed in hydraulic press and juice is strained out.

Considering pomegranate’s commercially potential, many small and marginal farmers have taken up the pomegranate cultivation. The present traditional marketing channel is not able to offer the remunerative price to the producers. Moreover, the present juice extraction system is not financially feasible for small farmers and entrepreneurs. Therefore, if a low cost, medium capacity system which involves
minimal processing for the extraction of pomegranate juice is developed, the farmers as well as small entrepreneurs including road side marketers can start up small value addition centre and get more remuneration.

Design considerations focused on the techno-economic status of the micro and small scale fruit juice processors who are the intended users of the machine. While designing the machine, considerations included high juice yield, high extraction efficiency, low extraction loss, high quality of juice and availability, quality and cost of construction materials would be care of.

**Considering the above fact, the present investigation was carried out with the following objectives.**

1. To determine of physical and mechanical properties of pomegranate fruit and arils.
2. To design and development of pomegranate juice extractor.
3. Performance evaluation and cost analysis of developed pomegranate juice extractor.
4. Quality assessment of extracted juice.

**The experiment was conducted in four phases.**

(1) Various physical and mechanical properties such as size, shape, surface area, volume, bulk density, porosity, true porosity, coefficient of friction, cutting force, crushing force and hardness, to be used in designing the various parts of extractor was determined.

(2) The crushing type pomegranate was designed and fabricated.

**Design considerations**

A. The cost of extractor that could be meet by small scale entrepreneurs and roadside small dwellers.
B. Easy to use and clean.
C. Cheap and easily manufactured with local available materials.
D. Easily maintainable.
E. The capacity of pomegranate juice extractor should be adequate considering the small scale entrepreneur.
F. Extractor is powered by single phase electric motor.
G. Extractor should be versatile, compact type, easy to use, fabrication with local available material resource.
Design of following components of juicer

(A) Feeding chute
(B) Carrier roller
(C) Blade to cut the fruits
(D) Crushing roller
(E) Juice collection platform
(F) Waste outlet
(G) Driving mechanism
(H) hp of motor

Working of developed juice extractor

Pomegranate fruits are fed through the feed chute from where the fruits fall into the grooves of carrier roller. In between the carrier rollers cutting blade is there. The fruits set in the grooves, are conveyed to the blade. When carrier rollers are rotating, fruit fall on cutting blade at that time fruit cut into two half and one half fruit fall into groove of one side carrier roller and other half fruit fall into groove of beside carrier roller. Beneath the carrier roller the crushing rollers are there which rotate in such a way that the head of crushing roller pierce into the grooves made over the carrier rollers. During rotation the crushing roller crush the half pomegranate and juice from the arils comes out. After that crushed peels are throwing into waste basket outlet. The extracted juice is collected and filtered.

(3) The quality comparison of juice extracted by conventional method (Juice extracted with mixture) and developed juice extractor was carried out in terms of pH, TSS, total sugar (°Brix), titrable acidity and total phenol.

(4) Performance evaluation

(5) Cost analysis
CONCLUSIONS

The following broad conclusions were drawn from the investigation.

Physical and mechanical properties

1. The other physical properties such as bulk density, true density, porosity, density ratio and coefficient of friction on glass, galvanized iron and wood surface was determined for pomegranate fruits and arils and those was found as 651.23±26.29 and 584.54±55.50 kg/m³, 980.11±26.55 and 1039.16 ± 22.47 kg/m³, 33.48±3.84, 43±5.72%, 0.66±0.04, 0.56±0.06, 0.437±0.030, 0.794±0.04 and 0.857±0.01 and 0.354±0.027, 0.523±0.016 and 0.574±0.010, respectively.

2. The mechanical properties of pomegranate fruit and arils an average cutting force, hardness and crushing force of pomegranate fruit and crushing force for arils was found as 22.28±1.115, 45.59±0.886, 25±0.823 and 1.65 kgf, respectively.

Design and development of juice extractor and evaluation of its performance.

3. The maximum and minimum machine capacity was observed at 15 and 5 rpm respectively which was of the order of 356.783 and 68.932 kg/ hr.

4. The maximum and minimum extraction efficiency was observed at 10 and 5 rpm which was found as 87.77 and 75.765 %.

5. The maximum and minimum extraction loss was observed at 5 and 10 rpm which was of the order of 24.235 and 12.23 %.

6. Considering the rpm at which the maximum extraction efficiency obtained i.e. 10 rpm, the machine capacity and the extraction loss at that rpm observed as 230.70 kg/hr and 12.23 % respectively.

The quality assessment of extracted juice:

7. Average pH of juice from developed extractor and juice extracted with mixture was found to be 3.323±0.025 and 3.947±0.046, respectively.

8. The average TSS of developed extractor juice and juice extractor with mixture was found to be 19.13±0.126 and 18.5±0.25 °Brix, respectively.

9. The average total sugar of developed extractor juice and juice extractor with mixture was found to be 14.80±0.09 and 9.81±0.042%, respectively.
10. The average titratable acidity of developed extractor juice and juice extractor with mixture was found to be 0.70±0.04 and 0.58±0.025%, respectively.

11. The average total phenolic of developed extractor juice and juice extracted with mixture was found to be 0.209±0.008 and 0.115±0.005 %, respectively.

12. From the observations on quality parameters of the juice extracted using developed extractor and conventional method, except total phenolic acid, values of other parameters i.e. such as pH, TSS, total sugar and titrable acidity was found slightly higher in case juice samples extracted by developed juice extractor as compared to the samples obtained by conventionally.

Cost analysis

13. The developed juice extraction machine cost was estimated as Rs. 50485/.

14. The estimated juice extracting cost with developed juice extractor comes out be 0.25 Rs/ kg while manual juice extracting cost 13.33 Rs/ kg. Indicating nearly 98.87% reduction in extraction cost by using the machine.

Salient conclusion

The developed pomegranate juice extractor, extract better quality juice as compared with conventionally used method from 230 kg /hr pomegranate with the extraction efficiency of 87% at a speed of 10 rpm. The cost of extractor is Rs. 50485/- while juice extracting cost comes to be 0.25 Rs/ kg (0.09 Rs/ 100 ml) resulting into the saving of 98.87 % as compared to manual method.