CHAPTER I
INTRODUCTION

1.1 General

The name pomegranate derives from the Latin word *pomum* meaning apple and *granatus* meaning seeded (Karkare and Siddique, 2012). The pomegranate has been grown since ancient times for its delicious fruits and as an ornamental garden plant for its red, orange or occasionally, creamy yellow flowers. The pomegranate (*Punica granatum* L.) belongs to the *Punicaceae* family. It is also known as the Chinese apple or *Apple of Carthage or Apple with many seeds* (Schubert et al., 1999).

The pomegranate and its usage are deeply embedded in human history and utilization is found in many ancient human cultures as food and as a medical remedy. Despite this fact, pomegranate culture has always been restricted and generally considered as a minor crop. The pomegranate tree requires a long, hot and dry season in order to produce good yield of high-quality fruit. Pomegranates are native to central Asia, but since the pomegranate tree is highly adaptive to a wide range of climates and soil conditions, it is grown in many different geographical regions including the Mediterranean basin, Asia and California.

This fruit is cultivated extensively in Iran, Afghanistan, India, Mediterranean countries and into some extent in the USA, China, Japan and Russia (Sarkhosh et al., 2009). In India, pomegranate is considered as a crop of the arid and semi arid regions because it withstands different soil and climate stresses. It thrives best under hot dry summer and cold winter provided irrigation facilities are available (Saxena et al., 1987). Owing to its low maintenance cost, tolerant to biotic and abiotic stresses, high yielding potential, better keeping quality and higher nutraceutical fruit value, popularity of pomegranate is increasing among the growers and consumers worldwide.

1.2 Production

At the global level, India is the world’s largest producer of pomegranates, followed by Iran (Varmudy, 2011). Other countries like Turkey, Spain, Tunisia, Morocco,
Afghanistan, China, Greece, Japan, France, Armenia, Cyprus, Egypt, Italy and Palestine also cultivate this product. At present, good-quality pomegranates come from Turkey, Iran, Afghanistan, Syria, Morocco and Spain.

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 Million tonnes and productivity of 12 MT.ha\(^{-1}\) in India. At present, Maharashtra is the leading state in acreage covering about 68.7 per cent of the area under pomegranate. Similarly around 70.2 % of total production comes from Maharashtra. The other important states next to Maharashtra with respect to pomegranate cultivation are Karnataka, Gujarat and Andhra Pradesh. India is the only country in the world where pomegranate is available throughout the year (Anon., 2016).

Gujarat ranks third in pomegranate production after Maharashtra and Karnataka, the total production of pomegranate in 2014-15 was 99300 tonnes from an area of 9400 hectares 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 (Anon., 2015).

1.3 Importance

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 source of proteins, vitamins, minerals and having wider application in medicine both in Ayurvedic and Unani system (Fadavi et al., 2006 and Mousavinejad et al., 2009).

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 (Faria and Calhau, 2011), in chemoprevention (Lansky et al., 2005) as microbicidal (Neurat et al., 2004) and as antihyperlipidemic (Fuhrman et al., 2005).

The significant biological properties of pomegranate fruits are attributed to its chemical composition and especially to the presence of polyphenols, such as hydrolyzable tannins, anthocyanins and ellagitannins (eg. punicalagin), condensed tannins (proanthocyanidins), flavonoids and phenolic acids (eg. punic acid) (Seeram et al., 2006). Other phytochemicals found in pomegranates are organic acids, sterols, triterpenoids, fatty acids, triglycerides, and alkaloids (Seeram et al., 2006).

1.4 Pomegranate Fruit

The fruit is divided into arils (composed by juice and seeds) and peels which include the interior network of membranes (Lansky and Newman, 2007). Pomegranate juice is the greatest contributor for pomegranate ingestion which contains 85% water, 10% total sugars, 1.5% pectin, ascorbic acid, and polyphenols (Aviram et al., 2000). Several studies have reported a series of results for its clinical benefits, such as reduction of systolic blood pressure in hypertensive patients, decrease of common carotid artery intima-media thickness (Aviram et al., 2004), attenuation of myocardial ischemia and the lipid profile improvement of diabetic patients (Rosenblat et al., 2006). In addition, its chemo preventive, chemotherapeutic, anti atherosclerotic and anti inflammatory (Kaplan et al., 2001; Rozenberg et al., 2006 and Adams et al., 2006) were also been investigated. All the aforementioned beneficial effects of pomegranate juice on human health have been mainly attributed to its strong antioxidant properties (Balasundram et al., 2006 and Rosenblat et al., 2006), since it is rich in free radical scavenging compounds such as anthocyanins (3-glucosides and 3.5-glucosides of delphinidin, cyanidin, and pelargonidin), ellagitannins (eg. punicalagin, the most abundant polyphenol reaching levels of over 2 g/L juice), flavonoids (eg. quercetin, kaempferol and luteolin glycosides) and polyphenolic acids (eg. ellagic and gallic acid) (Gil et al., 2000; Seeram et al., 2006 and Lansky et al., 2005).
The fruit develops from the ovary and is a fleshy berry. The nearly round fruit is crowned by the prominent calyx. The apex of this crown is almost closed to widely opened, depending on the variety and on the stage of ripening. The fruit is connected to the tree with a short stalk. The multi-ovule chambers (locules) are separated by membranous walls (septum) and fleshy mesocarp. The chambers are organized in an asymmetrical way. The chambers are filled with many seeds (arils). The arils contain a juicy edible layer that develops entirely from outer epidermal cells of the seed, which elongate to a very large extent in a radial direction. The sap of these cells develops a turgor pressure that preserves the characteristic external shape of these cells. The colour of the edible juicy layer can vary from white to deep red, depending on the variety. The arils vary in size and the seeds vary in hardness among different varieties. Varieties known as seedless actually contain seeds that are soft, as shown in figure below. Fruit quality depends largely on sugar and acid content of the juice. The edible portion of pomegranate is an excellent dietary source as it contains a significant proportion of organic acids, soluble solids, polysaccharides, vitamins, fatty acids and mineral elements of nutritional significance (Dhumal et al., 2014). A brief description of pomegranate plant parts and their constituents has been given in Table 1 below.

Fig. 1.1 Different parts of pomegranate fruit.
Table 1.1 Pomegranate plant parts and its constituents (Jurenka, 2008).

<table>
<thead>
<tr>
<th>Plant part</th>
<th>Constituents</th>
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<tbody>
<tr>
<td>Pomegranate juice</td>
<td>Anthocyanins, glucose, ascorbic acid, gallic acid, caffiec acid, catechin, minerals, amino acids, quecertin, rutin</td>
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<tr>
<td>Pomegranate seed oil</td>
<td>95% Punicic acid, ellagic acid, sterols</td>
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<tr>
<td>Pomegranate pericarp (peel, rind)</td>
<td>Phenolic punicalagins, gallic acid, catechin, flavones, falvonones, anthocyanidins</td>
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<tr>
<td>Pomegranate leaves</td>
<td>Tannins, flavone glycosides, huteolin, apigenin</td>
</tr>
<tr>
<td>Pomegranate flower</td>
<td>Gallic acid, Urosolic acid, triterpenoids including maslinic and asiatic acid</td>
</tr>
<tr>
<td>Pomegranate roots and bark</td>
<td>Ellagitannins, punicalin and punicalagin, piperidine alkaloids</td>
</tr>
</tbody>
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1.5 Pomegranate processing

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. Therefore, It is prime importance to work on minimizing these losses thereby it can increase their supply without bringing additional land under cultivation. A number of processed products can be manufactured and preserved for future time satisfying the consumer perception of a high nutritional quality and
convenience produce. These could also be help to have the good returns and will have the availability of the fruit throughout the year by increasing the shelf life of the pomegranate fruits as such for a considerable period.

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% (Adsule and Kadam, 1995).

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 (Adsule and Kadam, 1995).

1.6 Justification

Now a day’s pomegranate fruit demand increases in the market due to its excellent flavour, nutritive value and medicinal properties of pomegranate fruit. It has also good potentiality for processing into value added products having extended shelf life. In order to exploit and popularize the medicinal and nutritive values of the pomegranate to its fullest extent, it becomes essential to explore the different ways of minimal processing and post harvest technology applications.

In India, in spite of the known nutraceutical benefits and great global demand for potentially pomegranate derived products. However, about 10-15% fresh produce lose their market value and consumer acceptability due to improper post harvest management. Minimizing these losses can increase their supply without bringing additional land under cultivation. A number of processed products can be manufactured and preserved for future time satisfying the consumer perception of a high nutritional quality and convenience produce. These could also help to have the good returns and make the availability of the fruit throughout the year increasing the shelf life of the pomegranate fruits as such for a considerable period.

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 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.

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.