Chapter I
Introduction

Peanut is known as the ‘Poor man’s nut’ which is the edible seed of legume Arachis hypogaea Linn. The botanical name Arachis hypogaea Linn is derived from two Greek words, Arachis means ‘a legume’ and hypogaea means ‘below ground’ referring to the formation of pods in the soil (Devi et al., 2013).

Globally, with annual all-season coverage of about 70 lakh hectares, India ranks first in acreage and with an output of about 85 lakh MT of peanuts, it ranks second in production after China. The total national kharif-2017 acreage was 41.5 lakh hectares, of which Gujarat alone accounted for 39.1 per cent of national acreage. Gujarat is the leading state in production of peanut which was about 30.54 lakh MT from 16.25 lakh hectare areas during the year 2016-17. It shares about 50 per cent of India’s total peanut production. In Gujarat, Saurashtra region has largest share of production and the highest production (18.1%) was estimated for Rajkot followed by Junagadh (14.6%), Devbhumi Dwarka (11.3%), Jamnagar (10.2%) and Amreli (5.7%) (Anon., 2017).

Among all the nuts, peanut has an excellent nutritional profile and so it is widely used in weight management diets and meeting appropriate protein levels in the body. It has a desirable fatty acid profile for which it is used for weight management diets and is rich in vitamins, minerals and several bioactive compounds. It also contains nutrients beneficial for heart including mono unsaturated fatty acids (MUFA) and poly unsaturated fatty acids (PUFA), potassium, magnesium, copper, niacin, arginine, fiber, alpha-tocopherol, phytosterols and flavonoids. Important bioactive compounds like catechins and procyanidins are found in peanut skin which is known for anti-inflammatory effect on pro-inflammatory enzymes and nitrous oxide levels. Thus, it makes a substantial contribution to human nutrition (Lewis et al., 2013).

PUFA when consumed from peanuts, peanut butter and peanut oil may improve insulin sensitivity and reduce the risk of developing type-2 diabetes in women; such effects may be more effective for high-oleic peanuts due to the greater
presence of MUFA. The health-promoting effects of peanut consumption are the result of their fatty acid profiles as well as other functional constituents including vitamin E, L-arginine, soluble and insoluble fibre, phytosterols, as well as water- and lipid-soluble phenolic antioxidants. The numerous cardio protective nutrients and bioactives endogenous to peanuts and potential synergies among these components truly make the peanut a desirable plant food (Isanga and Zhang, 2007).

The search for vegetal protein sources with balanced amino acid profiles is increasing worldwide owing to high cost of animal protein which is an obstacle to the access to these nutrients by developing countries populations (Aidoo et al., 2010). Animal sources are high in cholesterol which is related to occurrence of heart diseases and increased blood pressures. Also, animal sources are deficient in fibre which increases faecal weight and the absence of fibre causes constipation problems. Human beings, as well as the majority of animals, cannot synthesize essential amino acids which must be obtained through the diet. Plant proteins serve as abundant sources of antioxidants and are easy to digest, free from certain allergens thus giving additional reasons for its mass use over costlier animal proteins. The linoleic fatty acids (belonging to omega-6 family of fatty acids) and α-linolenic fatty acids (belonging to omega-3 family of fatty acids) are considered essential as they cannot be synthesized and must be taken from food. Peanuts have high levels of protein that is more readily available when compared with protein from other sources (Mutegi et al., 2009).

Fats and oils and their products when fully oxidized in the body yield about 9 kcal/g as compared to protein and carbohydrate which yield about 4 kcal/g. There is also an increased palatability conferred on foods by the addition of fats/oils and a delay in the digestion of food, thus preventing premature sensation of hunger after eating. Lack of adequate supply of calories in the diet causes malnutrition, susceptibility to diseases and an impaired growth and developments (Pamplona and Roger, 2008).

Peanut oil is an organic material oil derived from peanuts, noted to have the aroma and taste of its parent legume which is most commonly used for frying foods, because of its high smoke point relative to many other cooking oils. Its major component fatty acids are oleic acid (56.6%) and linoleic acid (26.7%) along with
small amounts of palmitic, arachidic, arachidonic acid, behenic acid and lignoceric acid (Carrín and Carelli, 2010).

Most vegetable oils such as peanut oil, sunflower oil, soybean oil and corn oil are rich in mono- and polyunsaturated fatty acids such as alpha-linolenic acid, $\omega$-3 fatty acid, linoleic acid and $\omega$-6 fatty acid. Peanut seeds make an important contribution to the diet in many countries. They are a good source of proteins, lipids and fatty acids for human nutrition. A dry powder (peanut flour), obtained after partial extraction of oil, from the roasted peanut kernel, is commercially used as additive to increase the protein content of various food commodities including baked goods, sauces, dressing, etc (Grosso et al., 1997; Sanders, 2002).

The chemical and physical properties of fats and oils are mainly determined by the fatty acids that they contain and their position within the triacylglycerol (TAG) molecule. Peanut oil is pale-yellow oil with distinctive nutty taste and odour obtained from the processing of peanut kernel, but odour is almost removed with refining (Sanders, 2002). It has a high oleic content that is associated with its good oxidative and frying stabilities. It is non-drying oil that solidifies from 0 to 3°C (O’Brien, 2004). It is considered to be more desirable dietary ingredient than saturated animal fats because they helps to improve blood vessel elasticity, keeps the heart rhythm beating normally, thin the blood, which makes it less sticky and less likely to clot and support the immune system (Bucher et al., 2002).

Peanut oil has been considered to be superior to soybean oil during frying, developing fewer flavour defects with long-term use. Considerable importance has been ascribed to the role of the oleic/linoleic ratio (O/L) and iodine value (IV) in governing product shelf life. High O/L ratio and low IV have been associated with greatly enhanced shelf life and decreased rancidity of the product (Andersen and Gorbet, 2002).

Presently, major portion of peanut is being processed for producing the edible oil. But, it is advisable to produce various processed snack foods from the peanut because of its unique flavour and abundant nutrients (Jiao et al., 2015). Peanuts are readily acceptable as a cheap protein source and popular snack item that can be eaten
alone or combined with other foods (Adebiyi et al., 2002). Recently, peanuts have gained much attention as a functional food (Francisco and Resurreccion, 2008).

Peanut is mostly classified into three major group’s viz. bunch, semi-spreading and spreading according to its habit of growth. Each of the peanut types is distinctive in size, flavour and nutritional composition. George Washington Carver was a well known educator, farmer and a food scientist who developed various peanut products that revolutionized the agricultural economy. He developed more than 300 products and 105 ways of preparing peanuts for human consumption. According to a study in the University of Georgia, peanut was used to make products like mayonnaise, cheese, chili sauce, various peanut candies, cookies, peanut soups, cream vegetables and salads. In the United States, peanut is produced primarily for manufacturing peanut butter, but also for consumption as blanched, dry or salt-roasted peanuts, as honey-roasted peanuts, as 'ball-park' peanuts (roasted in-shell), as peanut cookies, candies and as toppings to various desserts (Nwokolo, 1996).

Peanut protein can be combined into a variety of food products without serious problem in terms of colour and flavour. The pleasant aroma, nutty flavour and smooth texture of roasted peanut have found great reception. In India, edible peanut flour is used in developing a variety of cost effective food formulations such as multipurpose food, fortified flour, malted food and high protein biscuits (Bassey et al., 2013).

Roasted peanuts is one of the most popular snack foods, in which roasting is a key step in the process that directly impacts its quality especially crispness, taste and flavour as well as shelf-life of the final product. In roasted peanuts, the volatiles are formed as a result of Maillard reaction, strecker degradation, caramelization of sugar and lipid oxidation (Chen et al., 2010).

Roasting is one among the processing steps involved in the nut industry to improve the flavour, colour, texture and overall acceptability of the product (Ozdemir and Devres, 2000). Understanding of the roasting process is important because roasting is processing step not only for peanuts, but for many other food products such as coffee, cocoa, grains and other tree nuts (Pittia et al., 2001). Roasting is critical to the development of colour, flavour and texture through chemical reactions, heat transfer and drying which occur during the roasting (Saklar et al., 2001).
The critical roasting parameters (roasting time and temperature) greatly influence the roasted product characteristics. As roasting time or temperature increases, the brown melanin colour intensifies in peanuts. The content of biological molecules such as free amino acids and peptides, fatty acids, phytosterols, lignans and vitamins changes during the roasting process. In addition the roasting process offers distinct food preservation properties by inactivating the food spoilage enzymes, undesirable microorganisms, toxins and contaminants (Raigar et al., 2017).

Some commonly applied methods for roasting of food products are hot air, coal-fired furnace and electric furnace. These roasting methods are time consuming, have high energy cost and lower production rate (Yang et al., 2010). Among the mentioned methods, hot air roasting is one of the simplest methods with low investment and operating costs. Hot air roasting is performed by heating the food material using hot air without the use of oil or water as a carrier.

Peanuts are processed typically by dry roasting or oil roasting methods. The most commonly used oil roasting methods for peanuts are deep frying and blister frying. The process of blister frying has not been scientifically defined but it involves the steps of boiling blanched peanut in water for certain time, draining the excess water and then deep frying the soaked kernels in vegetable oil resulting in a highly crispy, highly crunchy snack with blisters on the surface. But these methods have several disadvantages like alterations in the internal microstructure of peanut (e.g. cell wall rupture, protein body distension and cytoplasmic network disruption) and also their shelf life is shorter compared to dry roasting methods (Xiaolei et al., 2017). Hence the two dry roasting methods namely hot air roasting and microwave roasting were taken into consideration for research purpose.

Alternative roasting technology may help to reduce production costs associated with peanut products manufacturing. Microwave energy has benefits including reduced product cost by the increased production, improved quality and fewer heating problems (Decareau, 1985). Microwaves save energy by having instantaneous start-up and shorter heating time thus leading to greater nutrient retention, greater quality characteristics as well as increased production. Microwave heating allows internal evaporation to take place inside the food, which enhances the moisture loss during heating. Since microwaves penetrate within a food and not just at
the surface, heating occurs more rapidly and this accelerating heating provides a higher quality product in terms of taste, texture and nutritional content (Datta and Rakesh, 2013).

The microwave assisted dry roasting of peanuts has distinct advantages over the conventional roasting process. The intense heat is generated within the food material due to its uniform penetration and distribution upon exposure to microwave radiations resulting into faster heating rate thus reducing the processing time. In fact microwaves are used in food industry for baking as well as for other applications such as extraction, drying, blanching, pasteurization and many types of unit operation. The microwave roasting of peanut has profound effect on its physicochemical characteristics (Schirack et al., 2006b; Jittrepotch et al., 2010).

During the process of roasting, some chemical changes may occur in which sugars can condense with free amino acids, peptides, or proteins leading to the formation of brown Maillard reaction products with potential antioxidant activity. In addition to free forms, plants also contain considerable amounts of bound form antioxidant phenolics. It is, therefore, perceived that some processing methods might be employed to break these covalently bounded polymeric compounds to liberate into free forms so as to enhance their antioxidant capacity. For instance, it has been reported that heat treatment liberated the low molecular weight compounds into their free forms and hence increased the antioxidant capacity of peanut skin, hulls and kernel (Chetschik et al., 2010; Schirack et al., 2006a). Moisture content and water activity are parameters related to the development of chemical as well as sensory characteristics of roasted peanuts, as their association has been recognised with Maillard browning and the texture of roasted peanut. Roasting also reduces moisture content and changes the internal microstructure of peanuts to create the characteristic crunchy and crispy texture of roasted peanuts (Lee and Resurreccion, 2006).

The quality of roasted nuts and oilseeds mainly depends on conditions employed for roasting. Besides the formation of desired flavour, the structure of lipid storage cells gets damaged due to roasting which eases the oxygen attack resulting in proceeding of chemical reactions and a rapid decrease in oxidative stability. Lipid oxidation is responsible for a decrease in shelf life and generation of undesired flavour. These off flavours and off odours are generally referred as oxidative
rancidity, which makes the roasted peanuts less acceptable. Due to the anti-oxidative nature of peanuts, naturally occurring phytochemicals such as tocopherols and polyphenols play an important role in protecting nuts and oilseeds against fat deterioration (Chun et al., 2005).

Generally, peanuts can be roasted to equivalent surface colours using different time/temperature combinations. Similar quality can be achieved with different roasting conditions and roasting methods, so it is important to understand the quality differences between roasting techniques. This simple observation led to the overall goal of this research, which was to determine the quality parameters of peanuts roasted by two different methods. The kinetics of browning reactions contribute to, and are expected to correlate with, other key reactions in peanuts, and other roasted foods, associated with flavour, texture, antioxidant capacity, and so on (Van Boekel et al., 2010).

The method of roasting is known to affect the physical, chemical as well as sensory properties of roasted peanuts. Therefore, our attempt is to make understand the mechanism of roasting and identify the optimum condition for enhancing the roasting quality of peanut kernels. The present investigation will also lead to reveal the roasting characteristics of kernels obtained from selected peanut cultivars popularly grown in Gujarat especially in the Saurashtra region. Present research may result in a more comprehensive understanding of key reactions contributing to roasted peanut composition and texture, and may allow these properties to be utilized during industrial roasting.

**OBJECTIVES**

1) To determine the effect of different roasting method and process parameters on organoleptic quality of roasted peanut kernels.

2) To optimize process parameters for quality roasting for different roasting methods.

3) To analyse the physico-chemical, biochemical and functional properties of peanut kernels before and after roasting.