CHAPTER-II  
REVIEW OF LITERATURE

The literature regarding the composition of peanut kernel, different methods employed for roasting of peanut along with its physico-chemical, biochemical, organoleptic and functional properties has been reviewed. The relevant details are given hereunder.

2.1 Peanut Composition

In general, peanut kernel contains 44 to 50 per cent oil and 26 to 28 per cent of protein. Besides major nutrients, it is a rich source of dietary fibre, minerals and vitamins. The proximate composition of raw peanut kernel is given in Table 2.1.

**Table 2.1 Proximate composition and nutritional value of peanut kernel**

<table>
<thead>
<tr>
<th>Constituent</th>
<th>Value per 100 g</th>
</tr>
</thead>
<tbody>
<tr>
<td>Moisture (%)</td>
<td>6.50</td>
</tr>
<tr>
<td>Energy (kcal)</td>
<td>567.00</td>
</tr>
<tr>
<td>Protein (g)</td>
<td>25.80</td>
</tr>
<tr>
<td>Fat (g)</td>
<td>49.24</td>
</tr>
<tr>
<td>Carbohydrate (g)</td>
<td>16.13</td>
</tr>
<tr>
<td>Fibre, total dietary (g)</td>
<td>8.50</td>
</tr>
<tr>
<td>Sugars, Total (g)</td>
<td>4.72</td>
</tr>
</tbody>
</table>

**Minerals**

| Calcium, Ca (mg)         | 92.00           |
| Iron, Fe (mg)            | 4.58            |
| Magnesium, Mg (mg)       | 168.00          |
| Phosphorus, P (mg)       | 376.00          |
| Potassium, K (mg)        | 705.00          |
| Sodium, Na (mg)          | 18.00           |
| Zinc, Zn (mg)            | 3.27            |

(Source: USDA-NAL, 2015)
Table 2.2 Vitamin content and lipid content of peanut kernel

<table>
<thead>
<tr>
<th>Vitamins</th>
<th>Value per 100 g</th>
</tr>
</thead>
<tbody>
<tr>
<td>Vitamin B-6(mg)</td>
<td>0.348</td>
</tr>
<tr>
<td>Thiamine(mg)</td>
<td>0.640</td>
</tr>
<tr>
<td>Riboflavin(mg)</td>
<td>0.135</td>
</tr>
<tr>
<td>Niacin(mg)</td>
<td>12.066</td>
</tr>
</tbody>
</table>

**Lipids**

| Fatty Acids, Total saturated(g) | 6.279 |
| Fatty Acids, Total Monounsaturated(g) | 24.426 |
| Fatty Acids, Total Polyunsaturated(g) | 15.558 |

(Source: USDA-NAL, 2015)

Desai et al. (1999) studied on various composition of peanut owing to its high oil and protein content and found that it contained 5.46 kcal per gram energy, 44 to 46 per cent oil content, 25 to 34 per cent protein content, 18 per cent carbohydrate with considerable amounts of vitamin B1, B2 (1.44 and 0.13 mg/100g).

Misra et al. (2000) studied on different cultivars for their agronomic, nutritional and physical characteristics. For their study, instead of considering pod yield and shelling out turn separately, a combined trait of kernel yield was taken. Among the physical attributes sound-mature kernels, 100-kernel mass, light pink colour test and elongated kernels with tapering ends were considered desirable traits. Similarly, the kernels with low oil, high stability index, high protein, high sucrose, low reducing sugar and low free amino acids were considered desirable while studying their chemical attributes. They reported that the fatty acid composition, especially the ratio of oleic acid to linoleic acid (O/L ratio) determine the shelf life of processed peanut products.

Aremu et al. (2006) determined the proximate and physico-chemical composition of two varieties of Bambara peanut flours using standard techniques. The two varieties (cream coat and dark red coat) of Bambara peanut showed comparable mean values of crude protein and carbohydrate (by difference) of 11.56 and
11.05 per cent and 73.30 and 73.87 per cent, respectively. Physico-chemical characteristics of bambara peanut oils showed that they have similar mean values of the following parameters: Free fatty acid 0.85 and 4.80 mg g\(^{-1}\); Acid value 0.92 and 0.98; Saponification value 24.9 and 140.5 mg KOH g\(^{-1}\); Iodine value 21 and 120 mg iodine g\(^{-1}\) and peroxide value 86 and 290 for cream coat and dark red coat, respectively.

Atasie *et al.* (2009) reported proximate, physico-chemical and elemental analysis of peanut. The results showed that the peanut oil contained fat (47.00%), protein (38.61%), moisture (5.80%), crude fibre (3.70%) and ash (3.08%). Minerals (mg/100g) included: Na (42.00±0.71), K (705.11±0.86), Mg (3.98±0.04), Ca (2.28±1.94), Fe (6.97±1.62), Zn (3.20±0.11), P (10.55±0.68). The physico-chemical characteristics showed; saponification value, 193.20 (mgKOH/g), iodine value 38.71 (g/100g), acid value 5.99 (mgKOH/g), free fatty acid 3.01 (mgKOH/g), peroxide value 1.50 (meq/kg) and refractive index 1.449. The predominant fatty acid was found to be oleic acid (41.11%). The peanut kernel can thus be considered as a good source of protein with high nutritional value.

Ingale and Shrivastava (2011) determined the proximate composition, anti-nutritional and nutritional value of seeds of new variety of peanut (*Arachis hypogaea* L.) JL-24. The result showed that the peanut seed contain moisture (5.529%), crude fibre (1.149%), lipid (46.224%), crude protein (25.20%), carbohydrate (21.26%), ash (2.577%), calcium (0.087%), phosphorus (0.29%) and energy (601.856%). The total fatty acid composition was 10.44 and 33.51 per cent for saturated and unsaturated fatty acid, respectively. The knowledge of this study could be utilized for various food preparation and selection for breeding purpose.

### 2.2 Peanut Varieties

Peanut composition varies depending upon varieties, environmental variations, agronomical and irrigation practice, which helps for deciding on proper variety for precise selection of raw materials.

Datta *et al.* (2016) studied on performances of peanut varieties under sub-tropical climate of north east hilly agro-ecological region of India. Here the cultivation of rice on upland and medium land is not a profitable venture to farmers.
Therefore, to find out alternative crop with high yield potential cultivars a three year field study from 2008 to 2010 on agronomic evaluation of peanut cultivars under subtropical climate of North East hilly Agro-ecological region was carried out. The experiment consisted of fourteen peanut cultivars (V1- ICGS-76, V2- GG-2, V3- GG-13, V4-TG 37 A, V5-FeESG-10, V6-FeESG-8, V7-K-134, V8-GG-6, V9-SB-XI, V10-GG-11, V11-KAUSHAL, V12-GG-4, V13-GG-2, V14-GG-8) as treatment in randomized block design and replicated thrice. Results revealed that highest plant dry weight was produced by cultivar “KAUSHAL” (32.99 g/plant), while lowest was recorded with cultivar “FeESG-10” (16.32 g/plant). Cultivar GG-11 had produced highest pod and seed weight (34.80 g/plant and 20.62 g/plant, respectively) as compared to other cultivars, while lowest pod and seed weight (8.96 g/plant and 6.39 g/plant, respectively) with “FeESG-8”. Maximum pod yield (2.06 t/ha) was produced by GG-11 cultivars. Cultivar GG-11 had also recorded highest shelling percentage. Therefore, it is suggested that GG-11 a better option for substituting the upland and medium land rice during kharif season for enhancing the farmer’s income.

2.3 Roasting Methods

The two methods that were employed for roasting namely hot air oven and microwave has been reviewed and is given below.

2.3.1 Hot air oven roasting

Makeri et al. (2011) analysed the effects of roasting temperatures on the rate of extraction and quality of locally-processed oil from two Nigerian peanut (Arachis hypogea L.) cultivars namely Kampala and ex-Dakar. They found that high extraction rates were obtained by roasting the peanuts at 140 °C for 20 min with Kampala yielding the highest oil. Above 140 °C/20 min treatment, the rate of extraction decreased for both peanuts. Crude fat and total carbohydrates were found to be high in Kampala and protein high in ex-Dakar. Free fatty acids (FFA) contents of both oils were below 20 per cent and peroxide values (PV) were below rancidity level of 10 meq/kg for both oils.

Dhamsaniya and Patel (2013) conducted a study on standardizing peanut roasting process of peanut butter production and found that roasting is basically aimed
to develop nutty flavour in peanut butter thus need to be standardized. For their study, the peanuts were roasted in the temperature range of 110-190 °C and the durations were varied in the range of 15-60 minutes to standardize the roasting process for obtaining better quality of peanut butter. The results showed that roasting can be based on more objectively defined parameters such as moisture content and water activity of the roasted peanut and the minimum values obtained for the moisture content and water activity were 1.37 per cent and 0.54, respectively.

Claire and Lisa (2018) identified changes in the small molecular weight compound composition of the peanut as a result of dry-roasting and found that compounds associated with arginine and proline metabolism were found to be the most changed. Products of chemical degradation and compounds contained within the vesicular bodies of the peanut increased after roasting. The levels and types of low molecular weight compounds present were significantly affected by dry roasting which provided useful information about compositional changes due to roasting.

Xiaolei et al. (2018) studied the effect of different dry roast parameters on peanut quality. Runner-type peanuts were systematically roasted at 5 temperatures (149–204 °C) to three Hunter L-values of 53, 48.5 and 43, corresponding to light, medium and dark roasts. Moisture and tocopherol contents were more closely correlated with roast colour rather than temperature. Moisture decreased with darker roast colour, while the total tocopherols were greatest in peanut oils with darker colours. Yield stress of peanut pastes increased as the colour darkened which indicated spreadability correspondingly decreased with darker roast colours. The overall flavour of roasted peanuts was found to be optimized at 177 °C/15 min with the medium roast colour.

2.3.2 Microwave oven roasting

Megahed (2001) conducted a study on microwave roasting of peanut and its effect on oil characteristics and composition and found that the oils extracted from microwave roasted peanuts (MWRP) showed gradual darkening by time of heating. Colour indices of the oil samples were calculated to show the effect of heating on the oil colour. Chemical characteristics and fatty acid composition of the extracted oils were determined. In addition, peroxide value, conjugated dienes and trienes were determined and it was found that very low amounts of epoxy and conjugated fatty
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Acids as well as fatty acid peroxides were formed as detected by GLC, UV spectrophotometry and peroxide value determinations. Freshly extracted peanut oils subjected directly to microwave heating showed increase in formation of conjugated trienes. It was generally concluded that even short period microwave heating accelerates the formation of some undesirable and harmful compounds (e.g. oxidation products, transformed pigments, etc.) during peanut roasting.

Schirack et al. (2006a) studied the characterization of aroma-active compounds in microwave blanched peanuts and examined the chemical compounds responsible for off-flavour using solvent extraction/solvent assisted flavour evaporation (SAFE), gas chromatography-olfactometry (GC/O), gas chromatography-mass spectrometry (GC/MS) and aroma extract dilution analysis (AEDA). Selected compounds were quantified based on AEDA results using SAFE and GC/MS. Quantification, threshold testing and analysis of model systems revealed increased formation of guaiacol and phenyl acetaldehyde in the off-flavoured peanuts, which resulted in the burnt and stale/floral flavours noted by a trained panel.

2.4 Roasting Characteristics

The review collected on different characteristics of roasted peanuts namely physico chemical, biochemical and organoleptic characteristics are given in following sub-sections.

2.4.1 Physico-chemical properties

Agnieszka and Adam (2007) evaluated physical, chemical and organoleptic properties of peanuts roasted in hot air – with and without air flow, deep-fried in oil and treated in microwave. As the temperature increased, air flow speed, power (regardless the method) and moisture show decreased values, while peroxide value experienced alterations according to the temperature. Peanut colour, proved to be affected by thermal processing; the higher the temperature, the darker peanut colour. The most considerable alterations were recorded for peanuts deep-fried in oil and roasted with the use of dry method, i.e. hot air flow having temperature of 170°C and 180°C. The method of roasting influenced also peanut texture while the hardest ones resulted from dry method without air flow. The most advantageous organoleptic
properties, regardless the methods, featured the peanuts thermal processed at the temperature of 140°C.

Ayoola and Adeyeye (2010) conducted a study on effect of heating on the chemical composition and physico-chemical properties of peanut seed flour and oil. The results showed that the raw, sun-dried and roasted seeds contained 46.10, 43.80, 40.60 per cent fat, 24.70, 21.80, 18.40 per cent crude protein, 17.41, 27.19, 36.11 per cent carbohydrate, 7.48, 3.40, 1.07 per cent moisture, 2.83, 2.43, 2.41 per cent crude fibre and 1.48, 1.38, 1.41 per cent ash, respectively. There was a general decrease in the proximate composition after exposure to different heating methods but there was variation in the mineral contents of the seeds after heating. The physico-chemical properties showed; saponification values of the raw, sun-dried and roasted peanut oil, 201, 195 and 170 mg/kOH/g, respectively. iodine value, 110.7, 108.5, 100.7 wijs, free fatty acid 1.180, 0.891, 1.260 g/100g, acid value 2.35, 1.79, 2.52 mg/kOH/g, peroxide value 0.740, 0.603, 0.470 meq/ kOH. The roasted peanut can be considered as a good source of valuable minerals, while the raw peanut is a good source of protein with high nutrition value.

McDaniel et al. (2012) studied on compositional and mechanical properties of peanuts roasted to equivalent colours using different time/temperature combinations to attain equivalent surface colours using different roast temperature and time combinations. They observed that moisture contents ranged from 0.41 to 1.70 per cent after roasting. At equivalent roast temperatures, moisture content decreased as peanuts became darker; however, for a given colour, moisture content decreased with decreasing roast temperature due to longer roast times required for specified colour formation. Glucose content was dependent on colour and temperature, while fructose was only temperature dependent. Soluble protein was lower at darker roast colours and when averaged across temperatures, was highest when samples were roasted at 187 °C. Moisture content strongly correlated with several components including soluble protein ($R^2 = 0.80$) and peak force upon compression ($R^2 = 0.64$). They reported that the variation in characteristics related to roast conditions was sufficient to suggest influences on final product shelf life and consumer acceptability.

Kumar et al. (2013) aimed at comparing physico-chemical, proximate and mineral analysis of raw and roasted seeds of peanut. The results indicated that total
ash content of raw peanut (4.6%) was higher than the roasted peanut (4.1%) seeds. Crude protein content of roasted peanut was higher (26.1%) when compared to that of raw peanut (24.9%). Crude carbohydrates levels of raw peanut (25.3%) are lower when compared with that of roasted peanut (26.5%). Crude fat ranged from (39.1%) in raw peanut to (39.6%) in roasted peanut. The moisture content of the raw peanut (4.1%) was more than the roasted peanut (3.6%) because of non-exposure to heat. Seeds showed higher energy values both in raw and roasted conditions. Based on statistical analysis the results showed highly significant differences (P < 0.05) between the raw and roasted seeds.

Rosalva et al. (2015) analysed the physical and chemical characteristics of eight peanut (Arachis hypogaea L.) cultivars that were grown in Mexico for the physicochemical properties and fatty acid profiles of their oils to select the most promising candidate in terms of oil stability and nutrient composition. The results showed that the protein ranged from 28.5 to 32.9 per cent and the oil varied from 37.9 to 56.3 per cent. The major fatty acids found in the oil samples were palmitic (11.9–13.2%), oleic (45.2–53.8%) and linoleic (25.1–29.2%) acids. The oleic/linoleic ratio was between 1.8 and 2.1. The physicochemical characteristics under evaluation were: the iodine value (88.6–105.4), saponification value (142.5–181.8) and acidity (1.1–2.5%).

Raigar et al. (2017) conducted a study on optimization of microwave roasting of peanuts and evaluated its physicochemical and sensory attributes. The roasting quality was analysed by moisture loss, hardness, browning index, peroxide value and overall acceptability. A roasting time and microwave power dependent improvement in desired quality of roasted peanuts and extracted oil was observed attributable to the formation of antioxidant Maillard reaction compounds. The linear term of roasting time and microwave power were highly significant for all the measured response variables. The interaction term of roasting time and microwave power has significant influence on moisture loss, browning index and peroxide value. A second order polynomial model adequately described the roasting experimental data (p<0.0001, $R^2>0.90$) with an insignificant lack of fit (p>0.05).

Xiaolei et al. (2017) evaluated characterization of peanuts after dry roasting, oil roasting and blister frying. Peanuts were systematically deep fried, blister fried, or
dry roasted at 177 °C to Hunter L-values of 53.0 ± 1.0, 48.5 ± 1.0, and 43.0 ± 1.0, corresponding to light, medium and dark roasting, respectively. They found that peanut microstructure was least damaged after dry roasting. The moisture content decreased with increased surface colour, due to more moisture loss with longer heat processing time. For light roasting, blister fried peanuts had significantly higher moisture contents than the deep fried and dry roasted peanuts, while for medium and dark roasting, blister fried had lower moistures than the other two. Descriptive sensory analysis was able to distinguish the flavour and texture profiles of peanuts prepared by different roasting methods.

2.4.2 Biochemical properties

Bolton and Sanders (2002) analysed the effect of roasting on oil composition and stability of roasted high-oleic peanuts. Off-flavour due to lipid degradation is an important factor in the shelf life of peanut products. The use of recently developed peanuts with high oleic acid/linoleic acid (O/L) ratio has the potential to significantly extend the shelf life of roasted peanuts. To determine the full potential for shelf-life improvement of oil-roasted high-O/L peanuts, a study was conducted to examine the effects of roasting high-O/L peanuts (O/L = 30) in high-O/L (O/L = 23.2) or conventional (O/L = 1.5) peanut oil. Peanuts were roasted at 177°C to Hunter L values of 49 ± 1. Roasted peanuts were stored at 30°C for 20 weeks. Samples were taken at regular intervals to determine peroxide value, oxidative stability index (OSI), moisture content, and water activity. The O/L ratio of high-O/L roasted peanuts was 27.9 while it was 13.6 for the conventional oil-roasted peanuts. After 20 week of storage, peroxide value of conventional oil-roasted peanuts was 10.8 compared to 5.3 for the high-O/L-roasted peanuts. OSI values were 88.5 and 52.4 immediately after roasting for the high-O/L-roasted and conventional oil-roasted peanuts. OSI for both decreased, but differences remained similar throughout the storage period. Shelf life of high-O/L peanuts decreased when roasted in conventional O/L-peanut oil vs. high-O/L peanut oil.

Yoshida et al. (2005) evaluated fatty acid distributions of triacylglycerols and phospholipids in peanut seeds following microwave treatment. Peanut seeds were roasted for 6, 12, 20 or 30 min at a frequency of 2450 MHz using a microwave oven. The predominant lipid component was triacylglycerols and the lesser one
phospholipids, while steryl esters, free fatty acids (FFAs), and sn-1,3- and sn-1,2-diacylglycerols were minor ones. Following microwave roasting, a significant increase was observed in free fatty acids and in both forms of diacylglycerols. The greatest phospholipids losses were observed in phosphatidyl ethanolamine, followed by phosphatidyl choline and phosphatidyl inositol. However, the principal characteristics of fatty acid distributions in the triacylglycerols were evident after 20 min of roasting: unsaturated fatty acids, especially linoleic and/or oleic, were predominantly concentrated in the sn-2-position and saturated fatty acids, especially stearic and/or palmitic, primarily occupied the sn-1-position or sn-3-position of peanut oils during microwave roasting. These results indicated that unsaturated fatty acids located in the sn-2-position are significantly protected from oxidation during microwave roasting.

Adeyeye (2010) evaluated the effect of cooking and roasting on the amino acid composition of raw peanut seeds. The results showed that total amino acid was as follows: (g/100 g crude protein): 83.5 (raw seeds), 85.9 (cooked seeds) and 66.8 (roasted seeds) with corresponding essential amino acids as: 39.4 or 47.2 per cent (raw seeds), 38.3 or 44.6 per cent (cooked seeds) and 30.0 or 44.9 per cent (roasted seeds). Predicted protein efficiency ratios were 2.55 (raw seeds), 3.00 (cooked seeds) and 2.31 (roasted seeds) and essential amino acid index of 1.18 (raw seeds), 1.08 (cooked seeds) and 0.83 (roasted seeds). The following essential amino acids were reduced by both cooking and roasting: Lysine (15.9-27.6%), Histidine (4.23-16.5%), Threonine (40.1-60.6%), Methionine (38.0-63.4%) and Isoleucine (13.3-31.8%). All the parameters between raw seeds/cooked seeds and most of the parameters between raw seeds/roasted seeds were significantly different at r=0.05.

Jittrepotch et al. (2010) studied the influence of microwave irradiation on lipid oxidation and acceptance in peanut seeds. Peanut seeds were exposed to microwaves for 0, 2.5, 3.5, 4.5, 5.5 and 6.5 min at frequency of 2,450 MHz, 450 watts microwave oven. The quality characteristics of peanut seed (moisture content and colour values), extracted peanut oils (peroxide value, p-anisidine, free fatty acids) and acceptance test were analyzed. Moisture contents and colour values (L*) of seeds significantly decreased (P <0.05), whereas a* and b* values increased (P <0.05) from 0 – 6.5 min of heating time. The peroxide value, p-anisidine and free fatty acids of the extracted oils significantly increased (P <0.05). Lower acceptance in all attributes was observed
in the samples heated at 6.5 min, than in other samples. The results indicated that microwave irradiation on peanut seeds contributed to lipid oxidation and acceptability.

Liu et al. (2011) evaluated changes in volatile compounds of peanut oil during roasting process for production of aromatic roasted peanut oil. The analyses were performed by gas chromatography-mass spectrometry combined with headspace solid phase microextraction (HS-SPME/GC-MS). Among the volatiles identified in aromatic roasted peanut oil, the N-heterocyclic chemical class possessed the highest relative percentage area (RPA) 61.68 per cent, followed by O-heterocyclic group with an RPA of 24.57 per cent. Twenty pyrazines were considered to be the key contributors to the intense nutty/roasty flavour typical of aromatic roasted peanut oil. Compounds that increased significantly in concentration during the roasting process were mainly miallard reaction products, as well as compounds derived from strecker degradation and lipid peroxidation. The results clearly showed that the roasting process was necessary to obtain the typical nutty/roasty aroma of aromatic roasted peanut oil.

Rodrigues et al. (2011) conducted a study to reveal the impact of two factors, genotype (G) and treatment (raw or roasted peanut) (T), on the chemical composition of peanuts using a chemo metric method and Tukey's test. The peanut genotypes evaluated were cultivar cavalovermelho (CCV), cultivar cavalorosa (CCR) and cultivar tatu (CTA), in both raw and roasted states. The total lipid contents in the cultivar tatu and cavalorosa peanuts were 40 and 45 per cent, respectively. These values did not vary significantly after roasting. The cultivar cavalovermelho had the greatest total lipid content, but it decreased significantly after roasting (from 50 to 45%). The variation in the percentage of lipids in the CCV and CCR genotypes was not significant, in contrast to the CTA genotype. The fatty acid (FA) 18:1n−9 predominated in the CCR and CCV samples (50%), without any difference between their raw genotypes. The values for fatty acid 18:1n−9 were lower in the CTA peanut (40%). The second most abundant fatty acid was 18:2n−6 (CCV=28%, CTA=38% and CCR=25%), followed by 16:0 (CCV and CCR=16% and CTA=11%). The other fatty acids found in the peanuts were 18:0, 20:0, 22:0, 24:0, 20:1n−9 and 18:3n−3. The contents of fatty acids 18:1n−9, 16:0, 20:0, and 20:1n−9 suffered significant reduction after roasting in all genotypes. ANOVA analysis of the influence
of the main factors indicated that the contribution of the T variable for the majority of responses was low, being between 0.2 and 13 per cent, except for fatty acids 16:0 and 18:3n−3 and for the saturated fatty acid summations, which were 38, 60 and 22 per cent, respectively. There was a significant contribution from the G factor for all responses, with values between 17 and 99 per cent. The contribution of the interaction between the T and G factors was greater for the responses n6/n3 (56.6%) and for the fatty acid 16:0 (23%). The other responses had values between 0.02 and 14 per cent.

Smith and Barringer (2014) conducted a study on colour and volatile analysis of peanuts roasted using oven and microwave technologies. Raw peanuts were oven roasted at 135 to 204 °C, microwave roasted for 1 to 3 min, or combination roasted by microwave and oven roasting for various times and temperatures. Volatiles were measured using selected ion flow tube mass spectrometry. L* values were used to categorize peanuts as under-roasted, ideally roasted and over-roasted. The total roasting time in order to achieve ideal colour was not shortened by most of the combination treatments compared to their oven roasted equivalents. Oven before microwave roasting compared to the reverse was found to significantly increase the L* value. Peanuts with the same colour had different volatile levels. Hexanal concentrations decreased then increased with roasting. Pyrazine levels increased as roasting time increased, although oven at 177 °C treatments had the highest and microwave treatments had the lowest levels. Volatile levels generally increased as roasting time or temperature increased. Oven 177 °C for 15 min generally had the highest level of volatiles among the roasting treatments tested. Soft independent modeling of class analogies based on volatile levels showed that raw peanuts were the most different, commercial samples was the most similar to each other and oven, microwave and combination roasting were all similar in volatile profile.

Smith et al. (2014) experimented oven, microwave, and combination roasting of peanuts and their effect on inactivation of salmonella surrogate enterococcus faecium, colour, volatiles, flavour and lipid oxidation. Shelled raw peanuts were roasted using an oven at 163 to 204 °C, microwave, or oven and microwave combinations. Roasted peanut colour, odour activity values (OAVs), descriptive sensory panel analysis, free fatty acid, and peroxide values were determined. All treatments resulted in a minimum of 3 log reduction of inoculated bacterial population. Oven, microwave, and combination technologies produced equivalent
$L^*$ colour values and similar flavour quality based on the odour activity values and sensory results. No significant differences were found in free fatty acid or peroxide values between the raw and roasted samples, which concluded that lipid oxidation was not affected by the roasting treatments tested. Microwave technology can shorten the roasting time, which may decrease processing costs, while still producing similar odour activity values compared to the oven roasting and commercial peanut butter samples. Microwave combination treatments can also produce similar flavour quality based on odour activity values and sensory results and could be considered as a commercial processing option.

2.4.3 Organoleptic properties

Buckholz et al. (1980) studied influence of roasting time on sensory attributes of fresh roasted peanuts in which two varieties of peanuts, Runner and Spanish, were roasted at 163°C for 7, 8 and 9 min to produce light, medium and dark roast samples. Sensory evaluation was conducted with a trained panel using a 9-point hedonic scale to rate strength and desirability of odour and flavour. An analysis of variance performed on panel scores produced a standard deviation of 1.81. Statistically significant differences were found among varieties and roasting conditions. Volatile components were collected on Tenax GC followed by characterization and quantitation by gas chromatography (GC). Statistical analysis was used to correlate sensory and instrumental analysis. Stepwise regression showed good correlation between sensory properties and selected GC peaks. The coefficient of determination for the selected peaks averaged 0.9580. Prediction of strength and flavour quality will be possible using the developed equation $y = a + b_1 (x_1) + b_2 (x_2)$.

Braddock et al. (1995) studied flavour and oxidative stability of roasted high oleic acid peanuts. A new peanut line has been developed at the University of Florida with about 80 per cent oleic and 3 per cent linoleic acid. Volatiles and sensory characteristics of roasted normal and high oleic acid peanuts stored at 25°C were compared. Volatiles were analysed using adsorbent trapping and GCMS, a 20-member trained panel was used for sensory evaluation, and a GC sniffer port was used to evaluate odour characteristics of volatile isolates. Peroxide values were lower for high oleic (HO) peanuts than normal peanuts during storage at 25°C and 40°C. The hexanal content of the peanuts was higher for normal than high oleic. Peanutty
flavour was more stable for high oleic than normal after 6 week storage. Painty and cardboard flavours were higher in normal peanuts than high oleic during storage. Differences for both painty and cardboard flavours were significant after 6 week storage. Pyrazines were more stable in high oleic peanuts.

Smyth et al. (1998) experimented several analytical methods for optimising temperature and time of peanut roasting for making good quality snack foods. A laboratory roaster and commercial lots of peanut seeds were used to simulate the commercial process. Descriptive sensory analyses on roasted seed samples showed that optimal balance of important flavour characteristics such as roasted peanut, dark roast and sweet had distinct roast temperature and time requirements. Excessive heat increased negative flavour components such as bitter. Conventional tests for roaster control such as roast colour or seed moisture content changed only slightly during the period when optimal roast quality was achieved. For a given seed lot, optimal roast required both appropriate roast colour and taste of roasted peanut flavour. High oleic acid content of peanut seeds leads to greater stability in the flavour profile after roasting. They found that roasted seeds with 80 per cent oleic acid content resist rancidity and maintain roasted peanut character longer than conventional 50 per cent oleic acid seeds.

Schirack et al. (2006b) examined the impact of microwave blanching on the flavour of roasted peanuts. The peanuts reached a range of internal temperatures during microwave blanching treatments between 4 and 11 min. A total off note attribute was introduced to the peanut lexicon and was used successfully to differentiate the effects of microwave treatments. The microwave-associated off-flavour was related (but not identical) to cardboardy/stale flavour and was related inversely to the positive flavour attributes roasted peanutty, sweet aromatic and sweet taste. Peanuts reaching the highest internal temperatures and greatest moisture losses during blanching exhibited the most total offnote flavour; however, temperatures as high as 113 °C did not produce significantly increased total offnote intensity.

Lykomitros et al. (2016a) studied effect of raw material and processing technology on flavour, colour and fatty acid composition of peanuts. Flavour and colour of roasted peanuts can be influenced by raw material and processing technology. Raw peanuts of various market types, origins and grades were processed
by different technologies to produce 134 unique samples, which were profiled by a sensory panel and analysed for colour and fatty acid composition. Principal Component Analysis, Canonical Variate Analysis and General Linear Model regression were used to identify differences in flavour, colour and fatty acid profiles and to relate them to raw materials or process conditions. Data showed that raw material selection is key for flavour, but processing is also significant. Specifically, maceration significantly increased “roasted peanut” and “dark roast” aromas, reducing “sweet”, “raw bean” aromas, and sweetness. It also influenced colour and the fatty acid profile. Baking reduced “roasted peanut” and “dark roast” and increased “raw bean” aromas compared to frying, and impacted colour development.

Lykomitros et al. (2016b) also studied flavour of roasted peanuts and the correlation of volatile compounds to sensory characteristics. Results demonstrated that the correlation of CIELAB colour parameters with roast related aromas, often taken for granted by the industry, is not strong when samples of different raw materials are subjected to different processing conditions.