Wheat (*Triticum aestivum*) is a cereal that is cultivated worldwide. It is the most important human food grain. Wheat is considered unique as the basic raw material for the production of breads, biscuits, cookies and noodles, etc. because of its special gluten development properties as compared to those of other cereal grains. India is the second largest producer of wheat in the world with 86.87 million tonnes in the year 2010-11 contributing to about 12 per cent of world wheat production. Being the second largest populous country, it is also the second largest wheat consumer after China.

Noodles are the staple food in Asian countries like China, Japan and Korea and around 40% of total wheat flour is directed to noodle production in these countries. Asian noodles are prepared in a wide variety of types that are categorized based on formulation, particularly the presence or absence of alkali, cross-sectional dimensions, and post cutting processes such as steaming, frying, drying, or boiling. For consumers of these products, the quality of the noodles is primarily defined by texture and appearance. Processing method, ingredients, and grain quality traits have been found to influence the noodle quality. Instant noodles are generally made from wheat flour, starch, water, salt or kansui (an alkaline salt mixture of sodium carbonate, potassium carbonate, and sodium phosphate), and other ingredients that improve the texture and flavour of noodles, partially cooked by steaming and further cooked and dehydrated by a deep frying process. The properties of instant noodles like taste, nutrition, convenience, safety, longer shelf-life and reasonable price have made them popular worldwide. The growth of noodle consumption has been substantial, particularly of instant noodles. Instant noodles are consumed in more than 80 countries and have become internationally recognized food. Noodle industry supplies 95.4 billion servings annually to consumers throughout the world and the demands are on the rise. Over three quarters of this demand occurs in Asia.

Noodle quality is relatively complex and is differently specified for the plain salted, alkaline salt or other types of noodles. Noodles have been consumed for long in the Asian countries like China, Japan and Korea. Consequently, the locally preferred noodles have been studied extensively by the researchers and numerous scientific reports are available in
relation to the quality of these types of noodles. However, there is scanty information available for instant noodle quality. Moreover, this field is still unexplored in India and there is limited scientific research on Indian wheat varieties and their potential use for instant noodle production.

This research project, therefore, was aimed to study the biochemical characteristics and functional properties of wheat flour in relation to instant noodle making quality utilizing Indian wheat varieties. In order to achieve this broad objective, the framework of this investigation was developed by classifying the research work into following main task areas:

- Formula and process optimization of instant noodles
- To study functional properties of wheat flour for instant noodle making quality
- To investigate the biochemical characteristics of wheat flour constituents for instant noodle quality
- To establish relationship of the functional and biochemical characteristics with the quality of instant noodle

The effect of major ingredients including water (30-35%), alkaline salt (0.1-0.3%), guar gum (0.2-0.6%) and salt (1-2%) on the quality of instant noodles was studied using Response surface methodology (RSM) taking into account five response variables i.e. oil uptake, cooked weight, cooking loss, hardness and overall acceptability. In order to attain minimum oil uptake and good noodle quality, the formula ingredients i.e. water, alkaline salt, guar gum and salt were optimized as 30.97, 0.23, 0.28 and 1.54%, respectively.

Preparation of instant noodles involves many steps which were investigated for their effect on the quality and acceptability of the product. Five processing variables i.e. mixing time (4-12min), dough sheet thickness (1.0-1.5mm), steaming time (3-7min), frying temperature (130-150°C) and frying time (1-2min) were selected to study the effect of processing parameters on the quality of instant noodles using RSM. Process variables were found to be associated with the oil uptake, cooking as well as textural quality which are the important parameters determining the quality of instant-fried noodles. For acceptable noodle quality, the optimized values of processing variables mixing time, dough sheet thickness, steaming time, frying temperature and frying time were found to be 4.0 min, 1.2 mm, 6.4 min, 142°C and 2.0 min, respectively.
Instant noodles were prepared from fifteen diverse wheat varieties varying widely in their flour characteristics and dough rheology. Dough rheological parameters obtained by Mixolab and flour analytical properties were correlated with the quality of instant noodles including oil uptake, cooking quality and textural attributes. Mixolab parameters implied a significant variation among the flour samples in terms of dough strength, gluten quality and starch properties. Wheat cultivars characterized as weak i.e. HW 2004, HS 490, WH 1021 by the Mixolab were found to be unsuitable for noodle preparation. The desirable noodle texture of cooked noodles, which include a relatively firm and elastic bite was found to be dependent on protein quality reflected by dough development time, dough stability and thermal stability of gluten proteins. The Mixolab parameters dough development time and dough stability had a significant positive effect on quality of instant noodles. Falling number ($R^2 = 0.671$) and damaged starch ($R^2 = 0.523$) were revealed to be the critical parameters responsible for noodle stickiness. Dough rheology of good and poor noodle making flours was found to be distinct with a major difference in the mixing, pasting and gelling properties. DBW 16, WH 542, WH 283 and WH 147, were identified as best noodle making varieties, while HW 2004, C 306, WH 1021 and HS 490 demonstrated poor noodle quality.

The importance of quantity and quality of wheat gluten proteins in determining the oil uptake, cooking quality, textural properties and overall acceptability of instant noodles was also analysed using different wheat varieties. Mixolab parameters dough development time and dough stability were significantly positively associated with the gluten quality parameters like SDS sedimentation volume, gluten index, glutenin content, R/E ratio and Gli/Glu ratio of flour samples. Oil uptake and cooking time of noodles varied considerably from 15.4 to 22.7% and 2.0 to 4.0 min, respectively with protein content being the main factor responsible for this significant variation. Gli/Glu ratio also showed significant negative relationship with the cooking quality, textural properties and overall acceptability of noodles. Medium strong flours from wheat cultivars DBW 16, WH 542, WH 147 and WH 283 were most suitable for noodle preparation as the stronger flour samples of cultivars HI 977 and PBW 550 resulted into extra firm, over elastic and chewy noodles which were attributed to the extra strong dough characteristics, higher gluten index and R/E ratio, while lower Gli/Glu ratio of these cultivars; whereas the weaker flour from cultivars HW 2004 and C 306 could not withstand sheeting, resulted in rough surface and high breakage of noodles. The best noodle cultivars DBW 16 and WH 542 had 5+10 glutenin subunits at $Glu-D1$, however differed in subunits expressed at $Glu-A1$ and $Glu-B1$ loci. Wheat cultivars HW 2004 and C 306 with Null, 2+12
and 20 alleles expressed at *Glu-A1, B1* and *D1*, respectively were found to be unsuitable for instant noodle production due to excessive breakage during noodle processing along with higher oil uptake. Internal microstructure of good noodles showed a more continuous protein starch network as compared to the poor ones which had hollow and more extensive open areas.

The effect of wheat starch characteristics on the quality attributes of instant fried noodles was also examined. Higher values of amylose content, starch gel hardness and gel chewiness were found associated with lower oil uptake in noodles. Flours exhibiting higher starch pasting temperature and starch gel hardness contributed to noodles with higher cooking time. Starch solubility was found to be the main factor contributing towards higher cooking loss in noodles. Amylose content had a positive effect on noodle quality as it favoured lower oil uptake and cooking loss besides improving cooked noodle firmness and chewiness. Starch paste final viscosity and setback assisted a positive effect on noodle textural properties. The hardness of cooked noodles was mainly associated with higher amylose content, whereas starch solubility negatively affected it. The RVA parameters starch paste final viscosity and setback viscosity showed a positive association with the elastic character of cooked noodles. Flours with higher swelling power were found to be undesirable for preparation of instant noodles as they resulted in noodles having lower overall acceptability, springiness, chewiness and increased cooking loss in noodles.

Multivariate clusters analysis was done for physical parameters, protein, starch and noodle quality parameters of wheat varieties and was compared with the genetic diversity assessed utilizing RAPD molecular markers. The study of genetic diversity is important in a breeding program for the selection of suitably diverse parents to accumulate favourable alleles. The genetic diversity was assessed using fifteen RAPD primers. RAPD analysis in the present study was effective in grouping the good and poor noodle quality. Wheat varieties HW 2004 and C 306 which were poor noodle making varieties were segregated in the first cluster of dendogram suggesting that they were derived from same pedigree.

Health concerns related to instant noodle consumption are often attributed to the higher amount of fat content in the product. In this study, the ingredients, process factors as well as flour quality characteristics which influence the oil uptake during noodle production were identified. Other factors affecting the oil/fat uptake and strategies to reduce it can be identified and applied to remove such challenges and minimize the associated risks. The research implications may be effectively utilized for screening of superior instant noodle
making wheat varieties as well as attaining better noodle quality. The relationship between the formula ingredients, processing conditions and noodle quality may be utilized both by industry personnel as well as researchers to monitor the formulation and process steps accordingly and attain a better product. Fortification of instant noodles with essential micronutrients like vitamins and minerals, fiber and other flours which enhance their nutritional attributes can be targeted in future studies to ensure better nutrition to the people. Furthermore, the molecular markers may be utilized to identify the specific proteins related to noodle making quality of diverse wheat varieties.