2. REVIEW OF LITERATURE

An effort was made to collect relevant literature on the topic “Quality evaluation of weaning foods prepared from locally available agricultural produce”. This chapter contains relevant information compiled under the following headings:

2.1 Need of weaning foods
2.2 Age of weaning
2.3 Formulation of weaning foods
2.4 Quality evaluation of weaning foods
2.5 Cost analysis of weaning foods

According to Dorland’s medical dictionary “to wean” is “to cause an infant to cease from taking food by sucking and to take it in the ordinary way”. In Stedman’s medical dictionary, “to wean is to take from the breast; to deprive permanently of breast milk and to nourish with other food”. A weanling is a young animal that has become adjusted to food other than its mother’s milk. By the end of the weaning process, the infant no longer receives breast milk (or milk from a bottle), in the process of finally eating the family’s table food (Raphael, 1973). Thus, weaning is the substitution of solid foods or special childhood foods for breast or bottled milk.

2.1 Need of weaning foods

Most children between the age of 4 months and 2 to 3 years suffer from malnutrition. The reasons behind this fact are generally low incomes, poor sentimental conditions and lack of education. It is essential to educate families to use locally produced foods. (Cameron and Hofvender, 1983).

There is a need for nutritious weaning foods that are acceptable and affordable to low income populations. Guidelines state that an ideal weaning food must be nutrient dense, easily digestible, of suitable consistency and affordable to the target market (FAO/WHO 1985). Therefore development of supplementary foods based on locally available cereals and legumes has been suggested by the Integrated Child Development
Scheme (ICDS) and Food and Agriculture Organisation (FAO) to combat malnutrition among mothers and children of low socio-economic groups. In developing countries, cereals and legumes are commonly available. Evidence indicates that it is quite possible to improve the nutrient quality and acceptability of cereals and legumes and exploit their potentials as human foods by adopting newer scientific methods (Natarajan et al 1979).

Reddy et al. (1990) reported that nutritious weaning food for infants is the important way to prevent protein energy malnutrition. Protein energy malnutrition is an important nutritional deficiency condition that often occurs during the critical transitional phase of weaning in infants, crippling their physical and mental growth. This condition can be prevented to a large extent by introducing weaning foods of quality and quantity.

2.2 Age of weaning

Bakwin (1953) pointed out that because of the awkwardness of tongue and lips and the infantile extrusion reflex the infant is not ready for semi-solid foods before the age of 3 to 4 months.

The age when solid foods, or foods other than breast milk, are the first introduced into the diet is determined by local customs, food taboos, available foods, religious factors, advice of relatives and advisors, economics as well as the health of the mother and infant. Some cultures associate the first introduction of solids with the first tooth as in China (Sidel, 1973). In India rice is given to the infant in a special weaning ceremony (Jelliffe, 1968). In certain countries there are no special weaning foods, and the infant is breast fed until the subsequent pregnancy, going from the breast to a full adult diet as seen in Sudan, Somali land, Saudi Arabia and elsewhere. In Lebanon and Syria semi-solids from the adult diet are traditionally introduced as weaning foods.

Spock and Lowenberg (1955) gave the general recommendations that babies should be having some variety of solid foods by the age of 5 to 6 months; in some cases earlier than that; in others, later.

Walker (1990) recommended the introduction of weaning foods from the age of 4 months, when an extra source of energy and other nutrients, such as iron, is required, in addition to those present in human milk.
Weaning is not sudden withdrawal of child from the breast. It is gradual process starting around the age of 4-5 months, because the mother’s milk alone is not sufficient to sustain growth beyond 4-5 months. It should be supplemented by suitable foods rich in protein and other nutrients. These are called “supplementary foods”. These are usually cow’s milk, fruit juice, soft cooked rice, dhal and vegetables.

2.3  Formulation of weaning foods

Kapoor and Gupta (1981) prepared a low cost protein-energy-rich weaning food of acceptable quality by using soybean and cheese whey. Undamaged soybeans were soaked in 5 volumes of water containing 0.5 per cent sodium bicarbonate for about 12 hour at 25±2°C the soak water was drained and the beans blanched in boiling water for 30 min, cooled in tap water and dehulled manually; the cotyledons were separated from plumules by sieving and the hulls were removed by flotation. The soybean cotyledons were disintegrated with the entire amount of cheese whey in a micropulverizer. The slurry was passed through a muslin cloth, to remove any particles which would clog the homogenizer. The soy-whey mix was condensed to 35 per cent solids in a vacuum pan. Calculated quantities of fresh hydrogenated oil, fat-soluble vitamins and sodium citrate were added to the concentrate. The blend was homogenized in two stages, first at 3000 psi and second at 500 psi. The blend was fortified with ferrous sulphate (IP) to obtain the desired level of iron before spray drying in an Anhydro (Denmark) pilot-scale unit employing inlet and outlet air temperatures of 190±1°C and 95±1°C respectively. The powdered product was dry-mixed with water soluble vitamins and DL-methionine using a horizontal mixer. Synthetic capsoroma flavourings like vanilla, pineapple or strawberry were also added, before packaging. The manufacturing method, consisted soaking, blanching and dehulling soybeans, grinding the soy-whey mixture, adding oil and oil-soluble vitamins, homogenizing the mix, spray drying, fortifying with water soluble vitamin, flavouring, and packaging. The product was free from anti-trypsin activity.

Malleshi and Desikachar(1982) ragi (Eleusine coracana) and green gram (Phaseolus radiates) were steeped in water for 16 hr, and germinated for 48 and 24 hr respectively, dried and powdered after removal of the vegetative portion and bran. Refined ragi flour was mixed with green gram flour in the ratio of 70:30 to produce a malted weaning food (MWF).
Griffith et al. (1998) formulated weaning blends, in 60% cereal to 40% legume combination using teff, pearl millet, cowpea, and peanut. Amino acid scores were calculated using reported amino acid data for teff, pearl millet, cowpea and peanut. The blends were formulated in proportions as: PMP (60% pearl millet + 40% peanut), PMC (60% pearl millet + 40% cowpea), TPMC (20% teff + 40% pearl millet + 40% cowpea) and TPMP (20% teff + 40% pearl millet + 40% peanut). Four blends were prepared by each of four traditional processing methods: control (unprocessed), roasting, germination, and natural fermentation.

Reddy et al. (1990) formulated four weaning mixes using local foods and traditional processing techniques. The foods used to formulate the experimental weaning mixes were jowar (Sorghum vulgare), bajra (Pennisetum typhoideum), wheat (Triticum aestivum), rice (Oryza sativa), Italian millet, moth beans, green gram, Bengal gram, rajkeera seeds, potatoes and spinach leaves. The four techniques used were roasting, malting (germination), puffing and fermentation.

Ashturkar et al. (1992) developed four weaning foods namely, RGB-Rajkeera:greengram:Bengal gram dhal (2:0.5:0.5), BRB-bajra:riceflakes:bengalgram dhal (0.5:0.5:1), JSB-jowar:soybean:Bengal gram dhal (2:0.5:0.5), JPG-jowar:puffed Bengalgram:greengram (2:0.5:0.5), mixes.

Dominguez et al. (1993) prepared weaning foods by mixing decorticated and press-dried pearl millet (70%) and cowpea (30%) with and without sorghum malt. Decorticated millet and cowpea flours were cooked into slurry and press-dried to produce flakes. The heat applied during cooking of the slurry and press-drying to develop proper paste properties for the preparation of porridge like weaning foods.

Kshirsagar et al. (1994) used locally available ragi (variety ‘HR-374’), greengram (variety ‘BM-4’), groundnut (variety ‘ICGS-4’) and skim milk powder in the ratio of 35:35:10:20 to formulate a weaning food containing not less than 20% protein. Ragi, green gram, defatted groundnut and skim milk powder were blended in the proportion of 35:35:10:20. Different processing techniques like roasting of ragi, green gram dhal and groundnut; malting of ragi, germination of ragi and whole green gram followed by roasting in an oven and addition of 5% barley malt were adopted for developing the weaning food.
Prakash and Ramanatham (1995) developed high protein weaning blends from acid stabilized rice bran protein concentrate and rice, with or without greengram. Weaning mix 1 consisted of rice bran protein concentrate (25%) and rice flour (75%). Weaning mix 2 consisted of rice bran concentrate (20%), rice flour (60%) and whole green gram flour (20%). Rice flour and/or green gram flour was added to wet protein concentrate and mixed with water. The dispersion was subjected to simultaneous cooking and roller drying and finally the roller dried flakes were powdered in a mixer.

Nwanekezi and Okorie (2002) formulated three infant weaning foods using different processing methods from complementary mixtures of maize and groundnut (unprocessed maize + roasted groundnut; fermented maize + fermented groundnut and malted maize + malted groundnut). Equal weights of skim milk were added to all three samples to improve their protein qualities.

Plahar et al. (2003) standardized an extrusion cooking process for production of high protein weaning food based on peanuts, maize and soybeans. Different blends were evaluated to achieve desirable chemical, physical, functional and sensory characteristics with the maximum possible level of peanuts.

Suhasini and Malleshi (2003) formulated weaning foods based on malted wheat and malted chickpea (MWF), popped wheat and popped chickpea (PWF) and roller dried blend of wheat and chickpea (RWF). The composition of weaning foods were as: MWF (malted wheat 60%+ malted chickpea 30%+ skim milk powder 5%+ sugar 5%), PWF (popped wheat 60% +popped chickpea 30%+ skim milk powder 5%+ sugar 5%) and RWF (roller dried food based on the blend of wheat 60% +chickpea 30%+ skim milk powder 5%+ sugar 5%).

Afoakwa et al. (2004) prepared the traditional weaning foods by steeping maize in water for 24 hours, mixed with cowpea and co-milled into a meal. A 50% moisture dough was made with the addition of water and fermented for 24 hours. The product was dried using solar drier (40-60°C for 72 hours) and oven dried (60°C for 8 hours), and packaged in polypropylene bags.
Reema et al. (2004) prepared **burfi, pinni** and **sevian** from wheat flour, germinated wheat flour and germinated wheat flour supplemented with germinated green gram/soy flour. The grins of wheat, greengram and soybean were germinated for 24 hours at 25-37°C and dried at 600°C for 8 hours and milled into flours. Fresh carrots were grated and cauliﬂower leaves were chopped and sun-dried for 3-5 days and then powdered. The samples of germinated and ungerminated grains were used for preparation of **burfi, pinni** and **sevian** along with 5% supplementation of dried carrot or cauliﬂower leaves.

Sadana and Chabra (2004) developed low cost weaning foods namely **panjiri, kheer, halwa** and **dalia** using germination, malting, roasting and pressure cooking processes. The experimental formulations were based on germinated wheat, pulses (Bengal gram, green gram and lentil) and roasted groundnut in the ratio of 75:25:25. The grains were allowed to germinate at room temperature in wet muslin cloth for 24-48 hours. Germinated grains were dried at 60°C for 7-8 hours. Germinated and ungerminated dried grains were milled into flour and Dalia. The germinated grain flours were used to develop experimental formulations while ungerminated wheat formulations were treated as control.

Sood et al. (2010) prepared ready to use mixes by using cereals, pulses, vegetables/fruits and nuts with soy-whey. Different products like **idli, dhokla, halwa, sattu** and **upma** were prepared.

Imtiaz et al. (2011) developed five weaning food formulations(F1 to F5) by using locally available resources. The formulations were based on germinated wheat and mungbean sugar and skim milk powder were processed. For preparation of germinated wheat and mungbean flour, seeds were soaked in water for 12 h at 30°C ± 2, germinated for 60 hours at 33.5°C ± 2 in a seed germinator, dried at 60°C for 8 hours, dehulled, roasted at 145°C for 2 minutes and milled, after which weaning foods’ formulations samples were developed by mixing the ingredients. The compositions of formulations are: MF (Mungbean flour): WF (wheat flour): MP (full fat milk powder): S (Sucrose) =F1 is mixed as 1.2:6.8:1:1; F2 is mixed as 2.4:5.6:1:1; F3 is mixed as 3.6:4.4:1:1; F4 as 4.8:3.2:1:1 and F5 is mixed as 6:2:1:1.
2.4 Quality evaluation of weaning foods

Mallesh and Desikachar (1982) prepared malted weaning food by blending malted ragi and green gram flours in the proportion of 70:30 reported significant increase in amylase activity and decrease in paste viscosity with progressive germination of ragi and green gram. Ragi showed higher enzymic and viscosity changes than green gram. Hot paste viscosity of MWF (malted weaning food) was much lower than that of several proprietary brands of weaning foods manufactured in India. Reduction of the paste viscosity of weaning foods marketed in India can be effected by the use of barley malt flour. The proximate composition of MWF is similar to the popular proprietary weaning foods, it has 11.5 per cent protein and PER of 2.4. Clinical trials indicated that the MWF has good tolerance and growth promoting values when fed to children.

Dodd and Dutta (1988) analysed ten commercial infant and weaning foods and five home-made weaning foods, khichadi, sheera, ravakheer, rice kheer and dalia for their fat content and fatty acid composition. The fat content of commercial infant foods ranged from 6 to 24%, of commercial weaning foods from 1 to 9% and in home-made weaning foods from 0.5 to 3%. Only 3 infant formulae and one weaning food had essential fatty acids sufficient to provide more than 3% of total calories.

Dodd and Ratanani (1988) analysed ten commercial infant and weaning foods. The results indicated that the protein content of infant formulae ranged from 13 to 30%. While the protein content of weaning foods was similar to infant foods (16.7%), one of them had only 6.2% protein. The total essential amino acid content of the infant foods ranged from 421.1 to 468.2 mg/g protein and that of weaning foods from 416.5 to 446.8 mg/g protein. The sulphur amino acids were the first limiting amino acids in infant and weaning foods when human milk was taken as the reference.

Griffith et al. (1998) reported that the main effect of blend formulation proved to be the stronger determinant of nutrient density, while processing method produced the strongest effect on weaning food viscosity. Germinated blends yielded viscosity measurements significantly below those resulting from other processing methods. Germination of ingredients increased nutrient density and in vitro digestibility, while roasting and fermentation produced little change from the control product.
Complementation of cereal flours with peanut yielded weaning foods with a significantly (p<0.01) higher nutrient density, increased in vitro protein digestibility and lower viscosity when compared to cowpea–based blends. The use of 20% whole grain teff in weaning blends increased protein content but did not significantly increased non starch polysaccharide content as compared to weaning blends without teff.

Malleshi et al. (1989) conducted the shelf life studies on a low dietary bulk weaning food based on malted ragi and green gram were. The moisture humidity relationship studies at 27°C revealed that the moisture content of 11% and equilibrium relative humidity of 65% were critical with respect to free flowing characteristics of the product. The product packed in flexible pouches and stored at accelerated (38°C and 92% RH) and Indian Standard (27°C and 65% RH) storage conditions exhibited increases in moisture content, free fatty acids, cooked paste viscosity and decrease in alpha-amylase activity progressively on storage. The shelf-life of the product packed in low density polyethylene pouches was about 2 months and 3 months under accelerated and ambient storage conditions whereas in laminate pouches, the shelf life was about 3 months and 5 months in the corresponding storage conditions, respectively.

Ashturkar et al. (1992) The weaning foods supplied 349 to 362 kcal and 12.6 to 17.2 of protein per 100g. Among the four weaning foods RGB had the highest calcium and iron contents and the maximum per cent digestibility of proteins and carbohydrates.

Sometal. (1992) reported that roller–drying reduced in-vitro protein digestibility of weaning foods based on malted /roasted maize/rice and malted cowpea. Cooking of weaning foods improved protein digestibility as compared to uncooked blends. In vitro starch digestibility was similar in various blends of cooked weaning foods. Increasing the malted material in weaning foods improved the digestibility of protein, but not the digestibility of starch.

Dominguez et al. (1993) reported that Sorghum malt hydrolysed the starch and produced a beverage that contained (17%) protein with (90%) essential amino acids required for infants of less than one year old.
Kotwaliwale et al (1993) analysed equilibrium moisture content and water activity at 20°C, 30°C, 40°C and 50°C for two commercially available weaning foods by isotherm models and isosteric heat values. The analysis revealed that a range of water activity exists at all temperatures, at which major moisture related changes take place in these foods. At 50°C, where most possible storage conditions will be created, the storage stability of these foods is maximum at water activity of 0.275-0.315 and 0.285-0.350 corresponding to equilibrium moisture content of 0.026-0.028 g water/g dry solid and 0.047-0.055 g water/g solid. With increase in moisture content, the moisture binding energy decreases and moisture becomes more free. Isosteric heat decreases with an increase in moisture content at all four temperatures.

Kshirsagar et al. (1994) evaluated effect of roasting and malting of the constituents as well as addition of 5% barley malt on nutrient availability and rheological properties. The ionisable iron and soluble zinc were higher in malted and 5% barely malt added weaning food. However, *in vitro* protein and starch digestibility were higher in malted weaning food only. Malting and addition of 5% barely malt were found to reduce the cold, hot and cooked paste viscosity of weaning foods, thereby causing increased calorie density.

Akpapunam and Sefa-Dedeh (1995) reported the effects of traditional lactic acid fermentation and addition of malt on the physic chemical properties of maize-cowpea blends. The products were high in protein (18.4%-19.4%) and low in fat (0.5%-1.3%) and fibre (0.5%-0.7%). Fermentation reduced the pH from 6.7 to 4.4. The unfermented sample without malt was about four times as thick in consistency as those containing it.

Prakash and Ramanatham (1995) assessed high protein weaning blends from acid stabilized rice bran protein concentrate and rice, with or without green gram for their physico-chemical characteristics, and nutritional quality. The protein contents of weaning blends 1 (rice bran protein concentrate 25%+ rice flour 75%) and weaning blend 2 (rice bran concentrate 20%+ rice flour 60% +whole green gram 20%) were 20.6 and 21.8%, respectively. These represent calorie dense formulations with 377 and 372 calories/100g, which conform to ISI specifications. The protein efficiency ratios of blends 1 and 2 were
2.1 and 2.2, respectively. The formulations possessed high water absorption capacity of 310 ml/100g at 27°C, which increased to 360 ml/100 g at 60°C. The gruel viscosities of reconstituted blends were low, when compared to two rice-based commercial preparations.

Delgado and Saldivar (2000) added different concentrations of sorghum diastatic malt (SDM) to pre-gelatinized pastes from regular maize flour with the aim of hydrolysing the starch to produce liquefied foods with 15% solids. Viscosities of the blends decreased as the concentration of SDM increased. Addition of 6.66% SDM based on total amount of solids reduced viscosity by 50% when compared with food that did not contain any SDM. Addition of 33.3 or 46.6% SDM reduced viscosity by 70 or 75%, respectively. Most of the reduction in viscosity occurred within 1-3 min of incubation with warm water. Weanling rats were fed a combination 33.3% SDM and 66.6% of either quality protein maize (QPM), regular maize (RMZ) or decorticated pearl millet (DPM) to estimate protein efficiency ratios (PER), protein digestibility, biological value (BV), and net protein utilization (NPU). Rat growth was positively correlated with dietary lysine and essential amino acid (EAA) scores; therefore, animals fed QPM weanling food had significantly higher (P<0.05) protein digestibility corrected EAA scores, PER, BV and NPU than counterparts fed diets based on RMZ or DPM. This demonstrates that it is feasible to produce nutrition liquefied weaning foods blending 33.3% SDM with 66.6% QPM using simple processing techniques.

Nwanekezi and Okorie (2002) developed three formulations: UMRG (unprocessed maize+ roasted groundnut+ SMP), FMFG (fermented maize+ fermented groundnut+ SMP) and MMMG (malted maize+ malted groundnut+ SMP). The chemical composition and quality attributes compared favourably with each other but were lower than the commercial weaning food. Fermentation and malting reduced the bulk density. Malting increased PER (protein efficiency ratio) and FER (feed efficiency ratio). The reconstitution time for the three samples did not vary significantly with one another. All the maize-groundnut infant formulations had no significant differences in colour, taste and aroma. These formulations were significantly different in colour and taste than the commercial sample.
Plahar et al. (2003) standardised extrusion cooking process for production of a high protein weaning food based on peanuts, maize and soybean. Results showed bulk density and hardness increased while expansion index decreased with increase in feed moisture content. At a fixed range of feed moisture content, product bulk density and firmness decreased while expansion index increased with increasing extrusion temperature. For ease of extrusion and the best product quality in terms of sensory attributes and cooking properties, the following extrusion parameters were established for a blend formulation of 75% maize, 10% peanut and 15% soybean: feed particle size of 300-400μm extruded using a screw speed of 500rpm, with a feed rate of 4.6 kg/min, feed moisture content of 16-18%, and extrusion temperature of 100°C-105°C. Pair wise comparison of the sensory attributes of porridges prepared from milled samples of the weaning foods showed significant differences between extruded products, especially extruded raw (non-roasted) blend samples. In the Home-Use-Test, at least 92% of respondents in two out of three major ecological zones of Ghana placed overall sensory and functional characteristics of extruded raw blend samples as ‘highly acceptable’. About 7% of respondents scored sensory and functional quality attributes as ‘acceptable’.

Suhasini and Malleshi (2003) developed weaning foods based on malted wheat and malted chickpea (MWF), popped wheat and popped chickpea (PWF) and roller dried blend of wheat and chickpea (RWF). The foods contained 16.0-17.5% protein, 1.6-3.5% fat, about 65% available carbohydrates and 9.5%-10.4% dietary fibre. The PWF and RWF were blended with 5% barley malt flour, as a source of amylases, to prepare low bulk popped (PWFM) and roller dried (RMWFM) foods. The energy density of feed prepared from MWF, RWFM, PWFM, RWF and PWFM diets was 1.7, 1.6, 1.5, 0.6 and 0.5 kcal/ml, respectively.

Afoakwa et al. (2004) monitored proximate analysis, pH, titrable acidity, fat acidity, water absorption and cooked paste viscosity over six months under tropical ambient conditions (28°C, RH 85-100%) of weaning food prepared from maize and cowpea after fermentation. Cowpea addition caused only minimal changes in the studied indices with the exception of protein content, which increased from 10.54-14.34% and 10.71%-14.42% with 20% cowpea level, respectively, for the solar and oven dried products. Likewise, no major changes in proximate composition were detected during
storage. The product pH and fat acidity increased with concomitant decreases in titrable acidity in the stored samples. The pH levels increased from 4.67-5.18 and 4.13-4.71, respectively, in solar-dried and oven dried products within the six months storage period whilst titrable acidity levels decreased slightly during storage of the product.

Reema et al. (2004) analysed burfi and pinni, containing 5% dried carrots, sevian containing 5% dried cauliflower greens, for proximate principles, minerals, β-carotene, ascorbic acid, phytin P, polyphenols and in vitro protein and carbohydrate digestibility. The results revealed that soy supplementation significantly improved protein, fat, total and ionisable iron content in all the products. Products prepared from germinated flours showed significant decrease in phytin P and polyphenols with an improvement in starch and protein digestibility. Sevian were found to be nutritionally superior due to higher ascorbic acid, β-carotene, protein, iron, calcium, and zinc content compared to burfi and pinni.

Sadana and Chabra (2004) formulated low cost weaning foods from germinated and ungerminated grains of wheat, Bengalgram, green gram and lentil. All the formulations were evaluated for their acceptability by a panel of 12 judges using a Hedonic scale. All the formulations were found to be organoleptically acceptable obtaining moderately to extremely good scores ranging from 7.23 to 7.93. Germinated and supplemented grain flour weaning food formulations were more acceptable as compared to control products made from ungerminated grain flour.

Sood et al. (2010) prepared different products like idli, dhokla, halwa, sattu and upma and analysed for mineral and other nutritional parameters. The calcium content was found highest in sattu i.e. 213.33 mg/100g, whereas the sodium value was recorded in halwa as 19.33 mg/100g. The potassium were obtained as in idli (42.00 mg/100g) and phosphorus in upma was 245.00 mg/100g. Moisture content was highest in sattu, crude protein was highest in upma, crude fat was highest in dhokla and crude fibre was highest in sattu were 8.87 percent, 12.75, 7.66 and 3.57 percent respectively. Soy-whey based products are nutritious as they are good sources of proteins and minerals.
Elemo et al. (2011) produced weaning food from sorghum and cowpea based on a malted technology. Malted sorghum flour was produced (steeping, germination, drying, toasting, grinding and sieving) and steam cooked cowpea flour was produced. Both were blended in ratio 2:1 to get malted weaning food (GSC) germinated sorghum and cooked cowpea flour, Unmalted sorghum and steamed cooked cowpea in same ratio was also produced (USC) ungerminated sorghum and cooked cowpea flour. 72 hours gave optimum amylase activity with reduced dietary bulk in GSC due to 12.57 g (USC), samples met 1/3 RDA protein requirement for 1-3 years old child. Germination significantly increased essential amino acid except sulphur amino acids and tryptophan. GSC had amino acid value that appropriate FAO reference pattern except for threonine that was also the limiting amino acid. Vitamin A i.e. beta carotene (267.0 IU/100 g), thiamine (0.24 mg/100 g), and ascorbic acid (5.0 mg/100 g) were increased from 197.0 IU/100 g (vit. A) , 0.16 mg/100 g (thiamine) and 2.73 mg/100g (ascorbic acid) in GSC. Phosphorus and iron contents also increased from 91.65 mg/100 g and 4.01 mg/100 g to 100.0 mg/100 g and 6.40 mg/100 g, respectively.

Imtiaz et al. (2011) prepared formulations from germinated mungbean and germinated wheat. The proximate composition results indicated that the moisture was (5.26 to 5.12), protein (28.627 to 17.325), ash (3.144 to 2.609), crude fibre (1.865 to 1.321) and carbohydrates (69.561 to 60.2456) were significantly different (p>0.05) but were within the range of the standard specifications for weaning foods. Fat content (1.336 to 1.234), however, was low when compared to the standard specifications even though values were significantly different (p>0.05) when compared with the formulations. Calculated values for total energy provided by the blends ranged from 377.825 to 376.000 kcal/100g dry matter which was significantly different (p>0.05). The functional properties of weaning food formulations were not significantly (p>0.01) different. The overall acceptability score was highest (7.45) in F3 (36% germinated mungbean flour+ 44% germinated wheat flour+ 10% full fat milk powder+ 10% sucrose) weaning food followed by F4 ( 48% germinated mungbean flour+32% germinated wheat flour+ 10% full fat milk powder+ 10% sucrose) (7.20) ranging from ‘like slightly’ to ‘like
moderately’. The F3 weaning food was satisfactorily acceptable. The composition and functional properties of F3 (44% wheat flour 36% mungbean flour, 10% skim milk powder and 10% sugar) and F2 (56% wheat flour 24% mungbean flour, 10% skim milk powder and 10% sugar) formulations were close compared to the standard specifications.

Ahmad et al. (2013) prepared three weaning food samples using different combination of rice flour, gram flour and papaya powder along with equal quantity of milk powder had protein content varying between 18.42-19.02, fat content 1.5-1.7, carbohydrate 17.24-17.58% and ash content 3.5-3.8 respectively. The viscosity of three samples did not vary considerably (10% concentration viscosity found to be 35.3-36.7). Moisture content of weaning food was found in the range of 0.341-0.423 (OD), vitamin C in the range of 17.02-40.06 mg/100g, total plate count log TPC/g was found in the range TFTC. The result of sensory evaluation revealed that the sensory attributes like colour, aroma, taste and overall acceptability of all the three samples were in the range of 6-7. The samples packed in nitrogen flush packaging in pet jar and combination film had better quality as compared to air packaging in both the packs.

2.5 Cost analysis of weaning foods

Malleshi and Desikachar (1982) calculated the cost of malted weaning food (MWF) as Rs. 6.00 per kg while considering the price of ragi and green gram Rs. 2.00 and 5.00 per kg respectively.

Anand (1999) calculated cost of weaning foods according to the price of each ingredient used in the local market. The cost of developed weaning mixes ranged between Rs. 17.93 to 50.60 per kg, which is much less than cost of commercial weaning foods available in the market. Weaning foods incorporating skim milk powder and Bengal gram had higher values as compared to the other mixes.