CHAPTER - 2

REVIEW OF LITERATURE

The review of literature is one of the important aspects in the research process because it acts as a torch for the new research workers. Before writing the thesis, all possible available references on the topics, books, reviews, scientific papers and notes are referred. All available informations put in the correct order. The review of literatures related to the present study is presented on following heads.

2.1 Studies on Theoretical Orientation of Mushroom
2.2 Studies on Theoretical Orientation of Jowar and Bajara
2.3 Studies on Theoretical Orientation of other related nutrients

2.1. Studies on Theoretical Orientation of Mushroom:

Mushrooms are becoming popular on the Indian menu with people realising their flavour and food value. Mushrooms are recognised as non-conventional source of protein, which can bridge the protein gap in the Indian diet. Mushroom occurs in nature, they are classified into edible and non-edible category. Edible mushrooms are safe for consumption. Mushroom contains good quality of protein.

Mushrooms are assuming increasing importance as a source of food in view of their pleasing flavour, adequate protein with a high Digestibility Co-efficient. Mushroom protein is known to contain almost all the essential amino acids for human life, i.e. lysine, methionine, tryptophan, threonine, valine, leucin, isulcine, cystine and phenyl alanine. Mushroom supplementation with Millet diet may help to over come lysine deficiency dry
Mushroom (sazor-caju) 37 per cent contain protein. The fat content of different species of Pleurotus ranges from 4.08 per cent of fat hence mushroom is called low fat food, Bisaria, 1987.

Major neutral lipid in Pleurotus ostratus was a triglyceride in nature and substituted 8 per cent dry weight major fatty acid was olic acid (79.4 percent) while palmatic 14.3 per cent and linoleic 6.3 per cent are the minor fatty acids and present of especially find linoleic and archidonic acids and found the they were present in high concentration vitamins in Pleurotus species as reported by Bano and Srinivasan (1979) are thiamine content range from1.16 mg to 4.80 mg/100gms. Niacine content 780 to 108.7mg/100gm(dry Pleurotus species) Ascorbic acid (vitamin C) contents is higher i.e. 90 to 144 mg/100gm. Vitamin B12 =1.4mg/Kg (dry weight) estimated vitamin in Pleurotus species, the presence of thiamine, riboflavin, niacin and folic acid and high concentration of ergosterine and other vitamins are present like pantothenic acid, linoleic, pyridoxin, folic acid, Vitamin B12 etc., Memura Haque, 1989.

Bano Zakia et al (1963) have also reported the amino acid composition of a mushroom-Pleurotusspp. in comparison with egg. And the amino acids present in egg per 100 g of protein is – arginine 6.4, isoleucine 8.0, lysine 7.2, valine 7.3, leucine 9.2, threonine 4.9, histidine 2.1, phenylalanine 6.3, methionine 4.1 and tryptophane 1.5.

Daniel et al (1966) on his studies on albino rats indicated that the PER of poor Kaffir corn diet (1.99) in Millet to 2-71 and 2-80 as a result of supplementation with L- lysine and a mixture of L- lusine and DL- threonine respectively. They also calculated B. V. and digestibility coefficient of kaffir corn as 66.9 and 56.0. And the NPU was 49.3. Which did supplementation of l lysine and a mixture of l-lysine and dl- threonine to 52.0 and 59.8 improve. The Biological Value and digestibility was also improved b supplementation
of above mixture to kaflir corn and it was reach to 71.4 and 72.6 for l-lysine supplementation group and each to 78.3 and 76.5 for lysine and dl-threonine supplemented. They have also calculated the Biological Value, digestibility coefficient and net protein utilization of skim milk powder diet as 84.0, 87.8 and 73.1 respectively.

Bano Zakia (1967) contains 4.2% soluble carbohydrates, 1.66 % pentosans, and 32.26% hexosans on dry weight basis. Since, mushrooms are devoid of starch, the food is stored in the form of glycogen. The fat content in different species of Pleurotus ranges from 1.08 % to 9.4 % on dry weight basis, and on an average Pleurotus contain 2.85 % of fat. The crude fat of mushrooms in general includes representatives of all classes of lipid compounds including free fatty acids, mono di and triglycerides, sterols, sterol-esters and phospholipids.

Parvathi et al (1972) reported 79.0 per cent (186.22 ±36.93) nitrogen retention from 235.96 of skim milk powder diet fed to rats at 10 per cent protein level.

Hayes & Haddad (1975) reported that mushroom are a good source of energy also observed that mushroom that one pond (454gm) of fresh mushroom provides 120 kcal. Mushroom can be classed in the category of foods with are low in calorie.

Hayes & Haddad (1976) expressed that mushrooms contain protein, which consists of various amino acids. All the essential amino acid required by an adult are present in mushroom. Tryptophan & lysine are present in high concentrations as compared to cystein and methionine. These amino acids are absent in vegetable proteins, in intermediate in quality between vegetable and animal protein. The supplementary value of mushroom protein in vegetable diet therefore, of considerable significance.
Chang (1979) estimated vitamins in *Pleurotus* species, and reported the presence of thiamine, riboflavin, niacin and folic acid and high concentration of ergo-osterine, but are devoid of vitamin A activity.

Haque *et al* (1980). The percentage of fat was found to be as low as 1.6-1.76% in both species *Pleurotus* sajor-caju and *Pleurotus* flabutatus respectively. And 56.4gm to 54.8gm of carbohydrates in 100gm *Pleurotus* sajor-caju and *Pleurotus* flabutatus. Ash content was 9.8 gms in *Pleurotus* sajor-caju.

Thagumanavan, and Maniekam, (1980) studies the soluble protein and free amino acid contain of *Pleurotus sajor-caju* volvariella eliplasis and volvaceae content 6.3 per cent of the dry matter. The total free amino acid contains for various mushrooms ranged between 1.62 and 9.68 per cent. The digestibility, BV and NPU of the sporophore of sajor caju was evaluated my feeding trials om rat and found to be 84.1, 89.4 and 75.1 per cent respectively.

Haque and Chakrabarty (1982) proved by the experiement that the iron present in mushroom is in available form and is helped in its utilisation by presence of others enhancing factors like protein and ascorbic acid.

Gopalan *et al* (1984) suggested that *Millets*, the staple constituents of Indian diet, are deficient in two essential amino acids, namely, lysine and tryptophan. Mushroom which are rich in lysine and tryptophan, can effectively supplement the *Millet* in term of protein quality.

Alpna verma *et al*. (1987) studied the mineral contents of edible mushrooms and concluded that the *A. bitorus* was found to be superior to others in phosphorous, calcium, magnesium, potassium, copper and mangeses and *Pleurotus* sajor caju was found to be superior to others in
sulphur, sodium and zinc while V. volvacea was superior to other in iron content. The data showed that the cap had higher mineral content than stripe. evaluate three types of mushroom (A. bisporus, P. sajor caju, and V. volvacea) in order to get an idea of the status of various biochemical constituents in different parts under different categories of mushroom. And concluded that mushroom protein contains some essential amino acids which are found only in animal proteins and are lacking in the Millets. Mushroom when supplemented with Millets can be helpful in eliminating dependence on animal protein to overcome the amino acid (Lysine) deficiency.

They also showed that mushrooms are rich in protein but poor in oil and good amount of ash, carbohydrate, crude fibre content are present. A. Bisporus was found to be superior to others in NPN, starch and P. sajor caju was found to be superior to other varieties in protein, total carbohydrate all sugar while V. Volvacea was superior to other in ash and crude fibre content.

Authors also indicated that the caps of all varieties had higher amount of nutrients as compared to stripe mushrooms. In case of V. volvacea cap contained less amount of crude fibre as compared to stripe. Cap of P. sajor caju was found to have less carbohydrate and reducing sugar content as compared to stripe.

Bisaria et al. (1987) Nutritive value: Mushrooms are rich in high quality protein, so these can be utilized to supplement our daily diet, which is primarily based on Millets and deficient in protein. Millets are deficient in two essential amino acids; namely, lysine and tryptophan while mushrooms are rich in these two. The effect of different agro residues used for solid state cultivation of Pleurotussajor caju on amino acid composition of the fruit bodies of the mushroom was investigated.
They reported the digestibility of mushroom protein is also high. Mushrooms contain the following nutrients on fresh weight basis, water—90 %, protein—3.7 %, fat—0.40 %, carbohydrates—4 to 5 %, fibre—1.5 %, calories—30 (per 100 gm of mushrooms).

Memuna Hoque (1987) reported the carbohydrate present in mushrooms are trehalose, glycogen, mannitol and glucon. Fructose, gluclose and sucrose are reported to be in free form.

Memuna Hoque (1989) determined 30 % /100 gm protein in Pleurotussajor - caju and in the quantitative analysis, the author determine almost all essential amino acid in Pleurotussajor- caju and Pleurotusflabulatus in appreciable amount. The experimental eident showed positive nitrogen balance in mushroom fed diets. The digestibility of mushroom diets was 92.00 and 91.02 compared well with casein diet, 92.71. The NPU of mushroom diets were 73.99 and 76.42 for Pleurotussajor - caju and Pleurotus flabulatus and that for caesin diet was 84.11. The PER of the experimental mushroom fed diets were also comparable to that of caesin diet i.e. 3.45,3.50, and 3.80 respectively.

Radhakrishanan (1990), expresed that Mushroom are recognized for their nutritivr value. Mushrooms are rich in protein. The protein content of dry mushroom is about 37%

Alan and Padem (1991) reported that the portion content exceeded that of other vegetables except legumes and ther contents of certain minerals (eg.K, Fe & Ca) were high mushroom can, therefore an important contribution to human nutrition
Daraisamy et al. (1991) The percentage of fat in mushroom is below 2%. This fat is rich in linoleic acid, which is an essential fatty acid. It is recommended for heart patient since it has less cholesterol.

Chang (1993) reported that edible mushroom are a good source of several vitamins including thiamine, riboflavin, niacin, biotin and ascorbic acid. *Pleurotus sajor-caju* contains the highest amount of nucleic acids among the edible mushroom he studied i.e. 4.06 per cent on a dry weight basis. He reported amino acid composition of *Pleurotus sajor-caju* and *Pleurotus florida* as leucine 7.5 & 7.0, isoleucine 5.2 & 4.4, valine 6.9 & 5.3, tryptophan 1.1 & 1.2, lysine 9.9 & 5.7, treonin 6.1 & 5.0, phenylalanine 3.5 & 5.0, histidine 2.8 & 2.2, methionine 3.0 & 1.8 for *Pleurotus sajor-caju* and *Pleurotus florida* respectively. The total amino acids present in *Pleurotus sajor-caju* and *Pleurotus florida* are 46.0 and 37.0 respectively.

Khanna et al (1983) showed that inclusions of dried 'dhingri' (*Pleurotus florida*) at 5 per cent or 10 per cent level in the diet of hypercholesterolemic rats resulted in higher food intake without any effect on gain in body weight. They also observed that lipids, cholesterol and glyceride levels in plasma were significantly decrease on feeding dried *Pleurotus* in diet. However, the lipid lowering was more evident only at 5 per cent level of mushroom powder in the diet than that at 10 per cent level. On fresh weight basis mushroom contains nutrients are water 90 per cent, protein 3.7 per cent, fats 0.40 per cent, carbohydrates 4 to 5 per cent, fibre 1.5 per cent, calories 300 / 100 gm of mushroom.

Rai et al (1993) fruiting bodies of *Mushroom* contain 32.81 per cent protein, 8.1 per cent moisture, 39.8 per cent fibre, 0.32 per cent fats, 0.46 per cent iron and 1.8 per cent carbohydrate.
Hayes et al (1994) Vitamin Content of mushroom compare favourable with that of most vegetables. Mushroom are reported to be an excellent source of riboflavin and nicotinic acid and uncommon although several mushroom contain detectable amount of provitamins. And ash content was 9.8 gms in Pleurotus sajor-caju. And crude fiber content was 7.0-7.3gm in Pleurotus species. The mushroom contains fiber 10gm.

Jagatpati (1994) denoted the amino acid value of edible Pleurotus species. In comparison to the other edible variety and Hens egg. The leucine-4.4, isoleucine-5.8, valine-4.7, tryptophan-0.9, lysine-5.0, histidine-2.1, phenylalanine-2.0, treonine-4.2, arginine-6.7, methionine-1.3 mg / 100g of protein. He reported proximate value of mushroom as moisture 91.1 per cent, protein 7.4 per cent, fats 0.3 per cent, carbohydrates 4.0, protein on dry weight basis 26.9 per cent and calories 16 per cent.

Lintzel (1994) reported the digestibility of mushroom protein to be as high as 72-83 percent.

Rai (1995) suggested the vitamin 'C' content in several Pleurotus species, was found to range between 2.2 and 4.4 on fresh weight basis. He reported fruiting of Pleurotus sajor-caju contain lysine 5.7 per cent, methionine 3.0 per cent, tryptophan 1.3 per cent, threonine 5.0 per cent.

Alpana Singh et al (1996): Dehydration of mushroom does not have any loss of nutrients in it. Dehydration mushroom was found to be good source of protein and dietary fibre and high level of potassium (43.85 mg / 100 gm.). Dehydration mushrooms have longer storage life.

Bajaj et al (1996) Evaluate the Pleurotus florida at different stages of maturity and reported the proximate composition of Pleurotus florida into stage I (immature stage s) stage II (cap stage) and stage III (mature stage). The
mushroom protein contain 25 - 40 per cent on dry weight basis and estimated that *Pleurotus floridus* content 24.76 - 28.94 per cent protein. They observed that *Pleurotus floridus* was rich in protein (24.76 - 28.94 per cent), the estimated 24.76-28.94% protein from *Pleurotus floridus*. Analysed sporophores protein content was lowest at stage I (24.76 per cent) and highest at stage II (28.94 per cent) and it declined slightly at maturity (25.72 per cent).

They also evaluate the mineral content in mushroom and reported high amount of minerals in stage I (12.43 per cent) and the mineral value declines as maturity progressed (8.4 per cent) The soluble sugar were present in reasonable amount being higher in early stage (22.05 per cent) but decreased substantially as the maturity progressed to stage II (11.02 per cent) and finally the value increased marginally at the mature stage (14.7 per cent).

The mushrooms are poor in lipid content. Total lipid value was maximum 96.82 per cent) for stage I and decreased for stage II (4.91 per cent) and was 5.52 per cent at maturity. The fat which represented a minor component was rich in triglyceride and free fatty acids which constitute 55 - 69 per cent and 20 - 25 per cent of total lipids; respectively phospholipids was low ranging from 4.3 - 6.8 per cent of total lipids. The different fatty acid, present were leuric acid, (0.20 - 0.97 per cent), myristic acid (1.19 - 1.34 per cent), palmitic acid (10.89 - 11.92 per cent), stearilic acid in traces, oleic acid (15.56 - 31.75 per cent) and lenoleic acid (54.12 - 72.16 per cent).

Palmitic acid, oleic acid, linoleic acid were the principle fatty acid, lenoleic acid was the most predominant one, which was maximum at the stage II, less in stage I, and still less in stage III. Linoleic acid has also been reported to be predominant among fatty acid present in *Pleurotus sajor-caju*.
Latiff L.A. (1996) studied the mineral content of 7 species of edible fungus *Pleurotus* sajor-caju contain Mn. Na, Fe, Rb & Zn were present at high concentration in the piles & stalk. There was an obvious inverse relationship between Na & Rb concentrations notably in *Pleurotus* sajor-caju.

Chang (1997) assessed the vitamin C content of some mushroom and found 2 to 3 mg in *Pleurotus* oyster and 4 to 5 in *Pleurotus* sajor-caju.

Prasad (1997) found significant amount of thiamine and riboflavin and in fresh mushroom the riboflavin content is 0.31 per cent. He show the value of protein in mushroom 20 to 40 per cent on dry weight basis and 3.1 on fresh weight basis. Fat 0.8 per cent, carbohydrates 4.3 per cent, energy 43 kcal/100 gram. He reported the essential amino acid required by man including lysine, methionine, tryptophan, threonine, valine, leucine, isoleucine, cystine and phenylalanine are presented in mushroom.

Prasad (1997) reported the mushrooms are also an excellent source of vitamins such as ascorbic acid, pantothenic acid, niacin and folic acid. It contains minerals like calcium, phosphorus at appreciable amount of iron. The mushrooms contain significant amounts of thiamine and riboflavin and in fresh mushrooms the riboflavin content is 0.31 per cent.

### 2.2. Studies on theoretical orientation of jowar and bajara:

Much more worker have studies the nutritional quality of jowl (Sorghum) and badger (Pennisetum) Millet form the staple food of human race, wheat, jowar (Sorghum), and bajara (Pennisetum), maize are common Millets used. Millets as a whole are rich source of starch and good source of protein in an Indian diet. Millets are the most concentrated and cheapest source of food energy. Known Millet supply at least 50-60 of calories and 6 to
12 per cent proteins. The limiting amino acid in Millets are lysine and threonine and in addition to this sulphur amino acid and tryptophan.

*Millets* are the primary sources of energy and protein. *Millets* are also an important source of minerals. *Millets* are the major source of dietary fiber and phytic acid which may depress the absorption and availability of trace minerals.

Swaminathan (1938) The Biological Values and digestibility of grain proteins were investigated in rat-feeding trails. He reported values of 83 and 89 % for the Biological Value and digestibility coefficient of the protein, respectively when fed to rats at the rate of 5% level of protein intake. The protein efficiency ratio of bajara (Pennisetum) protein at the level was 1.2, higher than that of sorghum or finger Millet protein. The protein efficiency ratio of pennisetum at the 10 % level of protein intake was 1.4 to 1.8, respectively.

Walf and Corley (1939) found that omission of any one of the essential amino acids except arginine, from the diet of adult rat results into negative nitrogen balance and weight loss.

Rama Rao and Swaminthan (1953) on their experiment on chemical composition of different varieties of Bajara (Pennisetum), they reported the PER value of pearl Millet, Bajara (Pennisetum) as 1.4. They reported the mineral content of bajara (Pennisetum) ranged from 1.6 to 2.2 per cent.

Venkat Rao et al (1964) reported PER value of Bajara (Pennisetum) 1.3 to 1.8 while studying the amino acid supplementation as a means of improving the quality of protein.
Daniel et al (1965) studied the effect of supplementation of kaffir corn and pearl Millet and diet based on them with lysine and DL threonine on the nutritive value of their protein and reported the PER value of Bajara 1.70.

Jansen et al (1965): reported PER value of pearl Millet, Bajara (Pennisetum) as 1.83 in their study of amino acid supplementation of Millet grains as related to world food supply.

Saxena et al (1966) conducted feeding trial on albino rats by feeding jowar (Sorghum) diet reported average food intake 7.1± 1.6 gm Average weekly weight gain 5.60± 0.23, Average nitrogen intake 87.47± 15.8 mg, urinary nitrogen 41.46±5.8 mg, faecal nitrogen 24.31±48 mg.

Pushpamma (1968) compared the protein qualities of Bajra, Ragi, sorghum and maize in rat feeding experiment. And reported bajara was limited to lysine, sorghum was deficient in lysine, tryptophan and sulphur containing amino acid and maize was deficient in lysine, tryptophan, isoleucine and valine. Bajara as considered superior to sorghum, but protein supplements, including lysine, improved the dietary efficiency of both Millets.

Deosthale and Rao (1971) in their experiment proposed the lysine content of protein in the bajara (Pennisetum) variety ranges from 2.23 to 3.18 gms. They also stated that, since lysine is the first and threonine is second limiting amino acid in bajara (Pennisetum) proteins, the nutritive value of high protein varieties seems to be lower than that of the common varieties.

Somakurien et al (1971), reported PER value 2.40 for pearl Millet. They studied the improvement of protein value of poor pearl Millet by supplementing with limiting amino acids.
Pushpamma et al (1972) observed a significant growth response in rats when tryptophan was added to a lysine supplemented sorghum diet. This suggest that tryptophan is the next limiting amino acid after lysine in sorghum.

Parvathi P. Easwaran et al (1972) reported that supplementation of poor kaffir corn diet with calcium salt and vitamins found a significant increased in the growth of rats. Normal sorghum has the level of tryptophan (0.8 per cent) recommended by FAO / WHO expert panel as ideal for the human infant.

High lysine sorghum, with a level of 1.2 per cent tryptophan, has a 50 per cent higher value than the recommended level of tryptophan. Which would be converted into niacin in a child (WHO 1967) The WHO (1967) proposed 60 mg of tryptophan as physiological equivalent to 1 mg of niacin (where tryptophan is in excess of that needed as a protein component). A child consuming 100 gm of high - lysine sorghum (10- 13 per cent protein) would have enough excess tryptophan from sorghum to produced about 1 mg of niacin.

Gupta (1974) studied the varieties of sorghum vulgare for their chemical composition and presented the values of crude protein, ash, and ether extract and crude fiber. Which ranges from 11.51 to 16.90 per cent, 1.71 to 2.40 per cent, 2.67 to 4.43 per cent and 1.02 to 1.45 per cent respectively.

Ganapati and Chotra (1976) suggested that an excess of arginine present in Millet was one of the factors for the failure of growth in rats which was counter acted by supplementation of lysine at 0.36, 1 percent and 2 percent to the wheat, and casein diet.

Desai and Zande (1979) put the essential amino acid content of bajara (protein are as, arginine 6.8 to 8.4, isoleucine 4.0 to 5.9, methionine 1.7 to 2.4.
histidine 1.6 to 3.4, leucine 9.2 to 9.7, lysine 3.7 to 3.9, phenylalanine 3.1 to 4.5, threonine 2.8 to 4.1, tryptophan 1.1 to 1.9 and valine 4.7 to 6.4 gm / 16 gm N. Methionine and tryptophan was found to be limiting amino acid. The pearl Millet grain contains 12.3 per cent protein compared with 9.6 per cent in sorghum and had higher content of amino acids than sorghum. The BV and DC of bajara (Pennisetum) protein as determined by feeding on experimental rats at 5 per cent level of protein intake are 83 and 89 per cent respectively. At 10 per cent protein intake level PER of bajara (Pennisetum) was 1.20.

Chhidda Sing (1983) put the values that the protein content of jowar (Sorghum) may vary from 9 to 11 per cent. It is poor in lysine content (1.4 to 2.8 %) while very rich in leucine (7.4 to 17 %)

Manjrekar et al (1986) suggested that lysine supplementation to jowar (Sorghum), increased its PER. The faeces of rats fed jowar (Sorghum) and a cellulose containing diet had higher nitrogen content. With lysine as the first limiting amino acid in jowar (Sorghum), animal fed this Millet as exclusive protein source showed a reduced weight gain. They found out lysine content in jowar (Sorghum) 0.22-0.26 mg/g N. The PER of stored jowar (Sorghum) was 0.87 and new jowar (Sorghum) was 0.98. But when jowar (Sorghum) was supplemented with lysine, the PER was 2.21. They cleared that the PER value of jowar (Sorghum) protein was not affected by storage. They calculated the NPU value of casein diet as 82.6 per cent and jowar (Sorghum) diet as 43.9 per cent. And suggested that lysine supplementation of jowar (Sorghum), increased its PER. The faeces of rats fed jowar (Sorghum) and a cellulose containing diet had higher nitrogen content.

Noorfathima Khanum (1987) reported weight gain of 16.94 gms percent food consumed by rats having the FER value 0.17 on feeding jowar (Sorghum) diet.
Nishizawa N. et al (1990): investigated that proso Millet is deficient in lysine (89 mg / N gm) It was found by giving 10 per cent Millet protein to rat did no increase their body weight where as with supplementation of lysine and threonine showed normal growth. They found Biological Value of Millet protein diet alone was 63.8, and the Biological Value was improved upto 84.2 by supplementation of lysine and threonine.

Zubaida Azeem and K. Chitterma Rao (1994): In their experiment on protein quality of improved varieties of bajara (Pennisetum). They observed the total gain weight was 66gm. In the group fed with skim milk diet. Among the group fed with bajara (Pennisetum) the total gain weight was max. 43 gms, in the group fed with local diet and 24gm. In the group fed with experimental diet. The average PER of diet with skim milk powder was 2.90. They provided the diet to the different groups of rats at 8% protein level. They conducted experiment on 8 percent level of feeding to the weaning albino male rats. The rats were fed with presented, the PER values obtained by feeding of different varieties of bajara (Pennisetum) at 0.98 to 1.90.

Fredric N. Owens et al (1994) investigated the leucine need for growth of rats was 13.24 mg / gm of live weight gain and the maintenance requirement was 0.40 mg, per unit of metabolic

Pal et al (1996) proposed the protein content of the sorghum grain varies from 7 to 14 per cent on a dry weight basis. In general, the self-pollinated varieties contain a higher protein content than that contained by the hybrids. Prolamine and glutamine are the principal amino acids whereas the sorghum protein is deficient in Arginine, Lysine, Glycine, Tyrosine and Methionine. Compared to the other Millets, sorghum protein is deficient in lysine and rich in leucine.
The average composition of sorghum grains are protein - 7.4 to 14.2 per cent, lipid - 2.4 to 6.5 per cent, carbohydrates - 70 to 90 per cent, fibre - 1.2 to 3.5 per cent. The minerals contents are calcium - 11 to 586 mg / 100 gm, phosphorus - 167 to 751 mg / gm, and iron - 0.9 to 20 mg / gm.

Normal Potter and Joseph Hotchkis (1996): reported and recommended that Millet grains are comparatively low in protein, especially amino acid lysine and comparable with whole egg. The lysine limitation can be overcome by consuming Millets with other foods high in lysine.

Devdas, R.P. (2001) put forth the following value of bajara (Pennisetum), maize and jowar (Sorghum). She says 100 gram bajara (Pennisetum) contain protein 11.6 grams. Fats 5 grams, carbohydrates 67.5 grams, energy 361 kcal and fibre 1.2 grams. Hundred grams maize contains protein 11.2 grams, fats 3.6 grams, carbohydrates 66.2 grams, energy 342 kcal and fibre 2.7 grams. Hundred grams jowar (Sorghum) contain 10.4 grams protein, fats 1.9 gms, carbohydrates 72.6 gms, and energy 349 K cal and fibre 1.6 grams.

Shakuntala Manay, N. and shdaksharawamy, M. (2001): reported that sorghum protein is superior to wheat protein in Biological Value and digestibility. However, as an exclusive source of protein, B vitamins and minerals in the diet, sorghum is inferior to wheat. They also reported the average chemical composition of bajara (Pennisetum) grains, moisture 12.4 %, protein 11.6 %, fats 5.0 %, carbohydrates 67.1 %, fibre 1.2 %, mineral matter 2.7 %. The mineral matter is rich in calcium, phosphorus and iron. And the average chemical composition of sorghum as moisture 11.9 per cent, protein 10.4 per cent, fats 1.9 per cent, fiber 1.6 per cent, carbohydrates 72.6 per cent and mineral matter 1.6 per cent.
The bajara (Pennisetum) grain protein contains high proportion of prolamine followed by globulin and albumins. Among the amino acids tryptophan content is high and lysine content average to low.

2.3 Studies on theoretical orientation of other related nutrients:

This heading includes the references pertaining to the nutritional value of egg powder, nutritional qualities of skim milk powder, the storage life of skim milk powder and eggs powder. It also includes the Biological Values of other nutrients except mushroom, jowar (Sorghum) and bajara (Pennisetum).

Briggs and callorv (1919) It is revealed from the back reference, that, Rose and co - workers suggested smaller but critical amount of protein are needed for making enzymes that are essential for digestion and metabolic processes in the tissues.

If more protein is eaten than is needed for the essential functions, this extra protein is oxidized as the body has little capacity to store protein. As is the case with fat and carbohydrates. However protein is converted to body fat if total energy intake is excessive.

Boggs and fevold (1946) have studied various factors affecting the palatability of stored egg powders. The result indicated the effect of decreasing moisture content, gas packing and acidification on the shelf life of dehydrated egg powders during storage at 36.5° C. Egg powders of low moisture value, retained their palatability better than those containing high moisture.

Subha Rao (1964) in vivo carbohydrate digestibility studies showed that the faecal bulk is an indication of low digestibility of carbohydrates.
Leela et al. (1965) reported the PER of a poor ragi diet at 8 per cent level of protein (2.1) was higher than that observed at 6 per cent level of protein (1.47) supplementation of the ragi diet with lysine or lysine and threonine resulted in a significant improvement in the PER. The PER of the ragi was nearly equal to that obtained with the ragi diet supplemented with 10 per cent skim milk powder.

Jones et al. (1966) reported that rats fed extremely high levels of lysine also exhibited impaired growth rat of rats which can be counteracted at least in part, by extra arginine.

Srinivas et al. (1966) reported PER of the skim milk diet 3.59±0.60 at 10 per cent protein level. They also reported the amino acids present in skim milk as arginine 6.6, histidine 2.4, isoleucine 6.6, leucine 8.8, lysine 6.4, methionine 3.1, cystine 2.4, phenylalanine 5.8, tryptophan 1.6, valine 7.3, total amino acids 5.5.

Devdas et al. (1967) observed increased food intake and PER when red gram was supplemented with methionine and tryptophan.

Brown and Allison (1968) have shown that supplements of 1.7 per cent arginine to a 12 percent casein diet retard the growth of rats and lowered the nitrogen index. The effect was corrected by methionine supplementation.

Davadas et al. (1977) reported the PER 3.26±0.35 of rats on skim milk diet at 10 per cent protein level. They reported the Biological Value 88.71±7.84 and digestibility coefficient 66.75±3.26 of the rats fed on skim milk diet at 10 per cent protein level. They also reported NPU of the same grouped rat as 81.±4.40. They conducted that skim milk diet was superior in its protein quality among the ragi based diets.
Banerjee (1978) recommended the space required per rat. He reported 150 cm² floor area for rats having less than 150 gm and 250 cm² floor area for rats having more than 150 gm of body weight. And the minimum height of cage should be 18 cm.

Morgen Newton (1978) reveals that the arrangement of cages on the rack and positioning of rack in the room can influence the intensity of light that reaches to the animal cage. Environmental temperature is known to have additional effect on physiological phenomenon in laboratory animal. High ambient temperature result increased body temperature and decrease food consumption. Ventilation within the cage is essential for the removal of excess heat, humidity and extraneous gases.

Carpenter and Calloway (1981) suggested that rats have a much higher relative requirement of sulfur containing amino acids methionine and cystine than human do.

Vidyavihar (1984) state that the fifty per cent protein and crude protein content in the food stuff is determined by estimating nitrogen and multiplying with a conversion factor of 6.25 with the assumption that protein contain 16 per cent nitrogen N and non-nitrogen N is present. Keeping in view the high non-protein N in mushroom a factor of 4.38 was suggested.

Khader Vijay and Vental Rao (1987) used skim milk powder and whole milk powder for control diet for their work of supplementary relationship between protein on seasome and other gram. They put up the values of some of amino acids present in skim milk powder as lysine 8.8 per cent, methionine 2.9 per cent and cystine 0.5 per cent, threonine 4.7 per cent, tryptophan 1.8 per cent, and total protein 34 per cent and PER 3.43.
Swaminathan, M. (1985) reported in the chapter of discovery of essential amino acid. That the Rose and co-workers (1935) investigated 10 amino acids necessary for promoting growth and health of albino rats. They are arginine, histidine, lysine, tryptophan, phenylalanine, methionine, threonine, leucine, isoleucine and valine.

Sodhi and Mehta (1987) reported reduced appetite, and growth, delayed wound-healing, hyperkeratosis of skin changes in hair, anemia and reproductive failure because of zinc and copper deficiency.

Swaminathan, M. (1987) reported spray drying of egg made normal commercial practices does not cause any appreciable loss of vitamin A. vitamin D, thiamine, riboflavin, pantathonic acid. Only vitamin A is slowly destroyed during storages. The loss of vitamin A at the of six months storage at 15 F, 70 F and 98 F being 40, 50, and 70 per cent respectively. The losses of thiamine are 10 and 30 per cent respectively under the above conditions. During the preparation of milk powder, vitamin C is destroyed to the extent of 70 - 90 per cent. The losses in other vitamin are small (10 - 20 per cent). During storage of milk powder, however, there is progressive destruction of vitamin A.

Kaur & Kawatra (1991) conducted an experiment on young rats, which were fed with low and high level vitamins A diet supplemented with skim milk powder and summarised that the supplementation of skim milk powder to diet produced good effect in both deficient and high level vitamins A diet fed groups. They showed that vitamin A level in the diet affects the nitrogen metabolism more in inferior quality protein fed groups than in superior quality fed protein fed groups. On feeding the young rats with skim milk powder reported gain in body weight 48.0 ± 4.89 gms and PER value 2.91 ± 0.36. Authors showed 16.49 ± 2.15 gms protein intake on food intake of 164.9 ± 19.5 gm food.
Mercy Paul and Vijayalakshmi (1992) reported PER of skim milk powder diet fed to rat at 10% protein level, as 2.65 ± 0.25 with wt. gain of 72.02 ± 9.71 gm. Where protein intake was 27.39 ± 2.17 gm. Also they reported the 91.25% nitrogen retention of the skim milk diet fed to rat at 10% protein level. The NPU value buy the skim milk group was 92.09 ± 5.38.

Satyanarayana Rao (1993) studied the palatability of spray-dried, foam-mat-dried and freeze-dried whole egg powders packed in different packaging materials and observed that the flavour score remained unchanged at 4°C, 19.27°C, 37°C and 42°C. His studies indicated that the drying conditions, packaging materials and storage conditions have no significant effect on the palatability and acceptability of the product.