Rabbits are basically herbivorous nonruminant, but omnivorous in food habit. Therefore, they thrive on wide variety of feed stuffs i.e. grains, green grass, tree leaves, vegetable and household offals. Feed cost of rabbit farming is on an average 50 to 55 % of total cost. So, various attempts were made by various workers in different parts of the world to reduce feed cost by using different unconventional feedstuffs in the diet of the rabbit.

Rabbits being herbivorous animal they can utilise crude fibre of roughage efficiently. Rabbit due to caecotrophy behaviour, consumes soft faeces directly from the anus. Afterwards fermentation in the caecum provides necessary amount of vitamin B complex, bacterially synthesized protein and may permit further digestion of some nutrients by multiple passage through digestive tract. So protein and energy requirement for producing unit quantity of meat in rabbit was found to be lesser by 20% than other class of livestock species.

Unconventional feedstuffs may be classified as:

i) Agricultural crop residue
ii) Oil cake
iii) Sugar industry byproduct
iv) Fruit industry byproduct
v) Green fodder
vi) Forest by product and fodder tree leaves
vii) Meat processing factory waste
viii) Aquatic plants
ix) Animal organic waste

x) Aquatic plants
xi) Roots
xii) Miscellaneous byproducts

Performance of rabbit on different feed stuffs:

i) Agricultural Crop Residue:

1. Rice Straw: Chemical composition was given in the Table 1. It was found that in growing rabbit while rice straw at 0,15,25% level fermented with Tricoderma sp, Azotobacter sp was fed, body weight gain, nutrient digestibility were not different (Huang et al., 1990).

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2. Sunflower hulls: It was reported that 10% level of inclusion in the ration of rabbit was possible without any adverse effect on performance (Garcia et al., 1996).

3. Almond husk: It was found that in weaned New Zealand White (NZW) rabbit it can be successfully incorporated upto the level of 40 % replacing luceren meal when average daily gain (ADG) and feed conversion ratio (FCR) were reported to be 37 g/d and 3.2 respectively (Aderbigbe et al., 1990).

4. Cowpea haulm: Haulms are the stalks and dry leaves remaining after the crop is harvested. It was reported that growing rabbit when fed 50% cowpea haulm replacing wheat bran totally, they observed ADG, ADFI and FCR as 18g/d, 67g/d and 3.5 respectively (Aduku et al., 1986).

5. Peanut haulm: When 50% of this feedstuff was added in the ration of rabbit replacing wheat bran completely, ADG, ADFI
and FCE were found to be 17 g/d, 78 g/d and 4.5 respectively, indicating its inclusion in the ration of rabbit upto 20% (Aduku et al., 1986).

ii) Oil Cake:
1. Sunflower cake: It was reported that when NZW rabbits fed this cake at 20% level ADG and FCR were 27 g/d and 4.67. However this meal contains aflatoxin and tannin 1 to 2 % (Lebas and Colin, 1977).

2. Gaur meal: It contains trypsin inhibitor. It was reported that when 13 % of this meal was fed to weaner rabbit, average daily gain was found to be 19 g/d. They reported that with the increase of level of inclusion feed intake and FCE decreased significantly (Schurg et al., 1986).

3. Neem seed meal: The production of this meal is 3.30 lakh tonnes. The amino acid content in terms of lysin and methionine is comparable to GNC. It is bitter due to presence of Nimbidin and Nimbadiol. 20 % level may be incorporated in the ration without any adverse affect on growth (Banerjee 1982, Fajinmi et al., 1990).

4. Pam Kernel meal: When it was fed to NZW and California White rabbits at 16% level average daily gain and FCR were found to be 18 g/d and 4.72 respectively. So it may be incorporated 10 to 15% level.
5. Rapeseed meal: It contains tannin and gluco sinolates. When 20% rapeseed meal was incorporated in the ration of rabbit replacing soyabean meal average daily gain was found to be 35 g/d. Average daily dry matter intake (ADDI) and FCR were 96 g/d and 2.73 respectively (Throckmorton et al., 1980).

6. Cottonseed meal: It contains gossypol 20%. It was reported that CSM at 0.4, 0.8, and 16% produced growth 40.2, 37.0, 38.6 and 38.9 g/d without lysine supplementation and 36.2, 41.8, 39.0 and 40.5 g/d with lysine supplementation in weaned rabbits (McNitt et al., 1982). So CSM upto 15% should be acceptable in the diet of rabbit.

7. Soyabean meal: When it is incorporated at 0, 10, 20, 30, 40% level replacing lucerne meal in a ration of rabbit containing maize 36%, wheat meal 20%, lucern meal 40%, malasses 3%, vitamin and mineral 0.5% and salt 0.5%, daily weight gain, FCR and carcass yield were 37.1, 39.0, 40.6, 40.2 and 41.5 g/d; 2.83, 2.66, 2.72, 2.81 and 2.79; 62.12, 61.90, 61.54, 61.20 and 61.95% respectively in different groups with non-significant difference (Crespi et al., 1992).

iii) Sugar cane industry byproduct:

1. Molasses: It is an important byproduct of sugar industry. It contains about 35 to 50% sugar. It is a cheap source of energy. India produces about 5.3 million tonnes of molasses annually. It was reported that when rabbit was fed pelleted ration containing 5% molasses ADG and FCE were 33 g/d and 4.10 in contrast to 30 g/d and 4.24 when pelleted feed without molasses was fed (Cavani et al., 1988).

2. Sugar Beet pulp: It is a byproduct of sugar cane. It was found that it can replace 15% of barley grain without decreasing growth performance, however energy and nitrogen efficiencies were impaired by 5% in NZW x CW crossbred growing rabbits (Gracia et al., 1993).

iv) Fruit industry byproduct:

1. Apple pomace: It is a byproduct of apple processing industry, consisting of peel, pulp, seeds and 25 to 30% fresh apple. It was found that when apple pomace was fed to Soviet Chinchilla (SC) male weaner rabbit at 20% level ADG and FCR were 21 g/d and 3.40, indicating incorporation level upto 20% (Sawl et al., 1995).

2. Tomato processing waste: It consist of peel, pulp and seeds. It is available after the extraction of juice. It was observed that when it was fed to NZW growing rabbits at 20% level replacing lucerne meal, ADG and FCE were found to be 32 g/d and 4.11 respectively, indicating its incorporation level upto 20% (Alicata et al., 1988).

3. Citrus pulp: It was found that when citrus pulp at 30% level was used in pelleted diet and were fed to NZW growing rabbits ADG and FCE were found to be 29 g/d and 72 g/kg metabolic weight, indicating its level of inclusion upto 30% level (Ranjhan, 1990; Pascul and Carmona, 1985).

v) Green fodder:

1. Rice bean (Vigna umbellata): It is high yielding protein rich palatable fodder for rabbit. It was reported that when 25% pelleted feed was replaced by rice bean fodder, ADG, ADDI, FCR were 2055 g/d, 58.31 g/d/kg metabolic weight and 3.42 respectively. It indicated that 25% rice bean fodder on dry matter basis can be incorporated to rabbit ration (Das et al., 1999).

2. Stylo (Stylosanthes hamata): It was reported that this leguminous grass can be fed to rabbit at 25% level replacing maize. Dry matter intake was found to be 62.40 g/kg metabolic weight (Gupta et al., 1993).

3. Rye grass (Secale cereale): When
this grass in hay form was added to the ration of adult White Giant rabbit at 20% level, ADG, FCR, ADDI were found to be 18 g/d, 3.75 and 90 g/d respectively (Singh et al., 1994).

4. Congocignal grass (Brachiaria ruziensis): It was reported in a trial of this institute that when 50% pelleted ration was replaced by congocignal hay ADG, ADDI and FCR were 12 g/d, 106 g/d and 8.90 in adult local rabbit. It indicated that 25 to 30% replacement was possible in case adult rabbit on dry matter basis (Das et al., 1999).

5. Groundnut leaves: When this with stem after preparing hay was added to the ration of adult local rabbit, 50% level on dry matter basis replacing concentrate pelleted ration it was found in a trial of this institute that ADG, ADDI and FCR were 50% level of incorporation in rabbit ration (Das et al., 1999).

vi) Forest byproduct and fodder tree leaves:

1. Subabool leaf meal (Leucaenia leucocephala): It is highly palatable and rich in protein. It contains mimosine. When SLM in the pelleted form was fed to NZW adult rabbits at 25% level the daily gain, ADDI and FCR were found to be 10 g/d, 74 g/d and 7.4 respectively. So 15% replacement is possible (Gupta and Atreja, 1996).

2. Biul leaf meal (Grewia oppositifolia): It is small medium sized tree, mostly found at high altitude. Leaves are highly palatable, nutritious and can be fed to the animals during winter season. It was reported that when 50% BLM was fed to NZW adult rabbits at 25% level the daily gain, ADDI and FCR were found to be 10 g/d, 28 g/d and 7.4 respectively. So 15% replacement is possible (Singh and Negi, 1986).

3. Mulberry leaves (Morus alba): This is grown at high altitude upto 1200 m above MSL. The leaves are highly palatable and when fed at 50% level to Angora rabbit, average wool production per annum was found to be 247 g (Singh and Negi, 1986).

4. Tapioca leaves: This is tuber crop and is extremely grown in our country. At harvest time tuber is collected and leaves obtained are used to prepare meal. This is rich source of essential amino acids except methionin. When NZW rabbits are fed 20% and 40% TLM based diet ADG, FCR and carcass yield were found to be 19g/d, 18 g/d, 4.26, 4.31 and 58.6%, 57.8%, 20 to 25% (Ravindran et al., 1986).

vii) Meat processing factory waste:

1. Feather meal: Feathers are available in large quantities in the poultry processing plant which can be used to prepare meal. It was reported that when soybean meal was replaced by feather meal in the ration of rabbit at 3% level, ADG, FCR, PER (Protein Efficiency Ratio) were 27 g/d, 4.09 and 1.43 respectively. So, it can be used safely at 3% level (Feketa and Hegedus, 1986).

2. Blood meal: It was found that when blood meal was given to the ration of Soviet Chinchilla rabbit at 5 and 10% level in pelleted form, ADG and FCR were found to be 28, 29 g/d: 3.69, 3.53 respectively. So, this meal can be incorporated to the ration of rabbit safely 5 to 10% (Sahu and Prasad, 1990).

viii) Aquatic plants:

1. Azolla: It is an aquatic fern found in shallow pond, ditches and channels containing stagnant water. When fresh azolla was fed at 20% level replacing commercial pelleted feed showed average daily gain of 27 g/s. So, it can be incorporated in the diet of rabbit without any adverse effect on palatability, DM intake and growth (Sreemannaryana et al., 1993).

ix) Animal organic waste:

1. Poultry dropping: It was reported to produce satisfactory result in rabbit at 10% level in concentrate feed.
2. **Rabbit excreta:** It was reported in abroad that when dried rabbit manure was added to the concentrate ration at the level of 0, 40 and 98% in pelleted form ADG was 33, 39 and 12 g/d respectively, indicating 40% incorporation in the diet (Feketa, 1984).

**x) Root:**

1. **Carrot:** It is grown in subtropical climate and surplus amount after human consumption can be given to rabbit after making pieces and drying as energy supplement. The dry matter intake was found to be 81 g/d when it was fed to crossbred rabbit at post weaning stage (Partridge *et al.*, 1985).

**xi) Miscellaneous byproduct:**

1. **Sewage sludge:** The potential of these as feed supplement in rabbit diet was tested by Ekpanyong and Biobaku (1986). It is high in protein and low in fibre. While at 10% it was incorporated in the diet of rabbit they found moderate level of body weight gain.

2. **Whey:** It is one of the largest waste in dairy industry and around 7 kg whey is produced during production of 1 kg cheese. It was reported that when pelleted diet containing 5, 10, 20 % dried whey was given to grower NZW rabbits, higher daily gain, lower feed intake, higher final body weight and improved FCR were observed over control (Ekhaior, 1990).

**Anti-nutritional and toxic factors in the feed stuffs and its effect on growth performance of rabbit**

**Gossypol:** It is present in cottonseed meal causing tissue damage of heart and infertility in male. Moreover it has inhibiting effect on digestive enzyme causing disturbance in digestion and absorption. This leads to impairment in growth. So it should not be more than 10-15% in the ration of buck. It can be detoxified by addition of ferrous sulphate or boiling the cottonseed with water reduce toxicity.

**Glucosinolate:** It is a type of goitrogen present in the rapeseed meal causing the inhibition of thyroid gland, interfere with the synthesis of thyroid hormone. So gland enlarges in an effect to produce more hormone. This condition is called goiter.

**Lectins (Hemagglutinines):** It is toxic protein found in beans i.e. soybean, common beans which binds to the intestinal mucosa and cause extensive damage to microvilli. So it results in impaired absorption of nutrient and this reduce growth of rabbit. As cooking destroys this, so heat treated beans may be provided to rabbit.

**Mimosine:** It is a toxic amino acid found in leucaena which causes alopecia to rabbit, hence it should not be fed more than 10% continuously for a long period.

**Mycotoxin:** It is a toxic substance produced by mold Aspergillus flavus and A. parasiticus which grows on grass and other feed i.e. cottonseed meal, soybean meal. The toxin is called aflatoxin B-1, B-2, G-1, G-2, M-1 etc. They cause severe liver damage and rabbit becomes dehydrated, lethargic and develops ascites, jaundice and causes death.

**Tannin:** It is present in sunflower meal and leaves. It has adverse effect on feed intake of rabbit causing the reduction of protein availability and it may impair the metabolism of rabbit. So ultimately growth is hampered.

**Trypsin inhibitor:** Substance that inhibit proteolytic enzymes and thereby growth of non ruminants is reduced e.g. feeding of raw soybean to rabbit have resulted in reduced growth rate.

**Ration prepared incorporating unconventional agro - industrial by-product**

Mulberry leaf meal-40%, maize crust-17%, wheat bran10%, soyabean meal-15%, cotton seed meal-8%, fish meal-4%, molasses-3%, vitamin and mineral mixture-2.5%, common salt 0.5%. Replacing mulberry leaf
meal either by rice bean meal or congo signal grass meal or groundnut leaf meal ration may be prepared depending on availability. It was reported by different workers that cost of rabbit production may be reduced by 20-25% without hampering the production.

**Procedures for improvement of nutritional value of agro-industrial byproduct**

Different physical, chemical, biological treatments are practiced for this purpose. For example ammoniation, alkali treatment, fortification with urea and molasses, ensiling etc. For organic animal waste processing i.e. drying, formaldehyde treatment, ensiling is needed to kill pathogenic microorganism and to enhance nutritional value.

**CONCLUSION**

So, it can be concluded that rabbit being omnivorous in nature, can thrive on wide variety of unconventional feed stuffs without any adverse effect, thus lowering feed cost. But level of incorporation and deleterious substances are to be considered before selecting any unconventional feed in the diet of rabbit to reduce adverse effect on growth and production.

**REFERENCES**