Neospark

ROLE OF PROBIOTICS IN POULTRY DIET

Introduction

The concept of probiotics goes back to Elie Machinikoff who proposed almost 100 years ago that bacteria in fermented milk product may be capable to control bacterial fermentation in intestinal tract of men and thus are health promoting. Especially during a last decade the concept of probiotics applied in animal nutrition as well. For many decades antibiotics have been used as feed additives in various species of farm animals, to reduce the frequency of diarrhea under certain conditions. Furthermore, in most cases performance parameters like body weight gain or FCR improves up to 5%. These beneficial effects of feed antibiotics are generally explained by modification of the intestinal bacteria and their interaction with the host animal. Thus, the intestinal microbiota is not only involved in nutrient conversion along the gastro intestinal tract, but may also affect or support animal health. According to data from USDA and animal health institute, antibiotics are currently used in 90% of starter, 75% of grower and more than 50% of finisher feeds for pigs. Human use of antibiotics has been estimated 1.36-14.64 million kg/ year, while estimated antibiotics use in animal agriculture is 7.36-11.18 million kg/year. The use of antibiotic as feed additive might contribute to an increase of bacterial antibiotic resistant, the European union has decided to ban the antibiotics as feed additives from 1st January 2006onwards. Therefore, many activities were initiated to establish other substances with beneficial effects on animals via modification of the intestinal micro biota. Among these so-called alternatives to antibiotics are probiotics. These adverse effects of antibiotics discourage their use and suggest the use of beneficial live cultures (probiotics) promoting growth of beneficial bacteria – which acts same as antibiotic without its adverse effects. It effects like –

1. Improved growth rate and feed utilization of animals.
2. Preventing colonization of harmful microorganisms in animal intestine.
3. Alleviation of lactose intolerance.
4. Relief of constipation.
5. Neutralization of entero toxins produced by pathogens.
6. Antitumoral / anticarcinogenic effect.
7. Anticholesterolamic effect.
8. Immunity inducer.

The major effect may be medicated by a direct antagonistic effect against specific groups of organisms (pathogenic) resulting in a decrease in their numbers or effect on the metabolism and also stimulations of immunity (Fuller 1989).

Drawback of probiotics and prebiotics is the use of these may be of no use in overcoming the development of antibiotic resistance (Lyons, 1987) and also no suggestion has been made that probiotic could replace antibiotic in treatment of disease.

Probiotics	Animal Nutrition
Goal	Quick response
Effectiveness	Easy to assess
Characteristics of intake	As additive in mixed feed
Frequency of intake	10-20 times per day
Micro organism (most frequently used)	Enterococcus faecium, Bacillus sps, Sacchromyces cervisiae
Natural Habitat	Digestive tract, soil, fruits

Probiotics And Prebiotics – Definitions History And General Idea

Animal feed supplements that have a beneficial effect on the host animal by affecting its gut micro flora (Parker 1974).

A viable mono or mixed culture of microorganisms which, when applied to animals or man, beneficially affects the host by improving the properties of the indigenous macrobiota. (Haveneen, 1992).

Fuller (1989) defined Probiotics as a live microbial feed supplement, which beneficially affects the host animal by improving its microbial balance.

A microbial preparation which contains live and / or dead cells including their metabolites which is intended to improve the microbial or enzymatic balance at mucosal surfaces or to stimulate immune mechanisms. (Reuter 1997).

In simple words, probiotics can be characterized as selected and concentrated viable counts of beneficial bacteria and yeasts that are administered per os in order to establish a favorable intestinal microflora at the cost of pathogenic / harmful microorganisms thus preventing digestive disorder and / or promote animal performances. This process of microbial inoculations is based on principle of competitive exclusion (RUTZ) or microbial population manipulation (Metcchnicoff, 1907).

The term probiotic is derived from a Greek word ‘biotikos’ meaning ‘for live’. The dietary use of live microorganisms has a long history. Mention of cultured dairy products is found in the Bible and sacred books of Hinduism.

Soured milk and cultured dairy products such as kefir, koumiss, leben and dahi were often used therapeutically before the existence of microorganism is recognized. The use of microorganism in food fermentation is the oldest method of preserving food. Much of the world depends upon various fermented foods that are staples in diet since a long past. The present historical perspective on concepts related to intestinal micro ecology date back to Eile Metchnicoff (1907) and he is considered as inventor of probiotics. The term ‘probiotics’ was first used by Parker (1974) to describe ‘organisms and substances which contribute to intestinal microbial balance’.

The latest trend is the use of combination of live bacteria in a food and the inclusion of nutrients (usually sugars) that can be used by those bacteria – which giving a promising result. Combination of these two traverses the GI tract and resulted in a synergistic effect and termed s ‘symbiotic food’. The most popular combination to date appears to be Bifidobacterium and fructooligosacchirides.

Difference Between Antibiotics, Probiotics and Prebiotics

Criteria	Antibiotics	Probiotics	Prebiotics
Definitions	Antibiotics are agents produced by bacteria or fungi or synthetic in origin, that prevents the growth of other species of microorganisms (bacteria, virus, fungi or destroy them)	Probiotics are live microbial feed supplements that beneficially affect the host animal by improving its microbial balance.	Prebiotics are non-digestible food ingredients that beneficially affect the host by selectively stimulating the growth/or activity of a limited number of bacteria in the colon / intestine and thus improve host health.
Characteristics	Pure chemical compound synthetic in origin or produced from bacteria or fungi.	Living microorganisms which are singly or combination of friendly bacteria /yeast.	Non-digestible feeding ingredients, i.e., chemical compounds like oligosaccharides.
	Absorbed in GI tract.	Not absorbed in GT tract.	Not absorbed in GT tract.
	Improve growth and feed efficiency.	Improve feed growth and feed efficiency.	Improve feed growth and feed efficiency.
	Tissue residues remain in animal product which may be harmful to consumers.	No tissue residues.	No tissue residues.
	May cause mutation of other microorganisms and thus leading to resistant strains.	Cause no mutation of microorganisms	Cause no mutation of microorganisms.
Mode of Action and Activity	Blocks living cells (microorganisms) DNA, RNA or protein synthesis.	Produce acid, reduce pH and discourage growth of pathogenic microorganisms	It leads to production of butyrate and other SCFA which are quickly absorbed and can serve as an energy surce for host.
	Have a broad spectrum of activity.	Possess localized antimicrobial activity.	Control lower gut environment, metabolism and disease prevention.
	Use in feed in sub-therapeutic level and shows growth promotion of action.	Proliferate in the digestive tract and compete with the pathogenic bacteria.	Increase Ca and Mg level in colon and their absorption.
			Decrease triglyceride and cholesterol level
			Act as anticarcinogenic, antimicrobial, hypolipidemic and glucose modulatory activities improve mineral absorption and balance and antisteoprotic activity.

Probiotic Strain:

Any generally regarded as safe (GRAS) micro organism such as Lactobacilli, Bifidobacteria, streptococci, sacchromyces,etc., Shown in published research to have one or more of the following positive attributes.

- In vitro adherence to epithelial cells
- In vitro anti microbial activity
- In vitro resistant to bile, Hcl and pancreatic juice
- Anti carcinogenic activity in clinical trails
- Immune modulation or stimulation in clinical trails
- Colonization of the GIT in clinical trails.

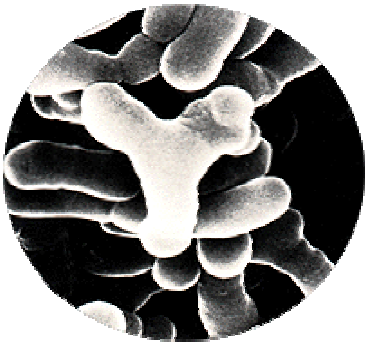
Classification of Probiotics

They are broadly classified as:
1. Bacteria, mainly lactic acid bacteria (LAB)
2. Fungi or yeast

LAB bacteria are: Lactobacilli sps., Bifidobacterium sps., Lactococcus sps., Streptococcus sps., Enterococcus sps. and other species.

Yeast/Fungi are classified as:
1. Saccharomyces sps.
2. Trichlosporon sps.

Lactobacilli sps.:
They are non-sporeforming, non-flagellated Grampositive facultative anaerobic rod or coccobacilli.



The guanine and cytosine content of their DNA is between 32 mol% and 51 mol%. They are either aerotolerant or anaerobic and strictly fermentative. In homofermentative case, glucose is fermented predominantly to lactic acids. Lactobacilli are classified under LAB and to date 56 species of genes *Lactobacillus* have been identified.

Bifidobacteirum sps:
They are non-motile non-spore forming catalase negative, Gram positive anaerobes.

They have various shapes including short, curved rods, club-shaped rods and bifurcated Y-shaped (bifid) rods. The guanine and cytosine content of their DNA is between 54 mol% and 67mol%. They are saccharolytic organisms that produce acetic and lactic acids without generation of CO_2, except during degradation of gluconate. The bifidobacteria population is influenced by a number of factors including diet, antibiotics and stress. Bifidobacteria are classified under LAB and todate, 30 species have been isolated.

Lactococcus sps.:
They are Gram positive facultative anaerobes found in dairy products and is commonly responsible for the souring of milk. They are classified under LAB

Streptococcus sps.:
It is a non-motile, non-sporeforming homofermentative, cytochrome oxidase and catalase negative Gram positive facultative anaerobes classified under LAB. *Streptococcus thermophilus* is an alpha-haemolytic species of the Viridans group found in milk and milk products and it is the probiotic used in production of yoghurt.

Enterococcus sps.:

Enterococci are usually non-motile, non-sporeforming, catalase negative, Gram positive, facultative anaerobic cocci from spherical to ovoid and occur in pairs or short chains under Streptococcaceae family and are part of the intestinal microflora of human and animals. *Enterococcus faecium* SF68 is a probiotic strain that has been used in management of diarrheal illness.

Saccharomyces sps.:
They belong to the unicellular non-pathogenic fungi (yeast) family. *S. boulardii* has been used to treat diarrhoea associated with antibiotic use.

Composition of Probiotics

Probiotics can be compounded in various ways depending on the sort of use intended. They can either included in the pelleted feed or through their food (Fuller 1989). Probiotic preparation may be made up of a single strain or may contain any number up to eight strains. The advantage of multiple strain preparations is that they're active against a wide range of conditions and in a wider range of animal species.

Fuller (1989) listed the following organisms are species used in probiotic preparations, Lactobacillus bulgaricus, Lactobacillus plantarum,, Streptococcus thermophillus, Enterococcus faecium, entero coccus faecalis, Bifidobacterium species and E.coli. With the exception of Lactobacillus bulgaricus and Streptococcus thermophillus, all the other organisms are all intestinal strains.

Lactobacillus, Streptococcus and Bifidobacterium are the commonly used groups in the production of probiotics.

Characteristic of good Probiotics

Fuller (1989) listed that following as features of a good probiotic.

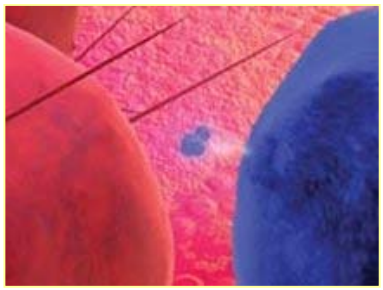
- It should be a strain, which is capable of exerting a beneficial effect on the host animal.
- It should be non-pathogenic and non toxic.
- It should be present as viable cells preferably in large numbers.
- It should be a capable of surviving and metabolizing in gut environment eg; resistant to low pH and organic acids.
- It should be stable and capable of remaining viable for periods under storage and field condition.
- Ability to colonize in GIT.
- GRAS – generally recognised as safe

Types of probiotic organisms used in Poultry

Lactobacillus acidophilus, *Lactobacillus bulgaricus*, *Lactobacillus lactis*, *Lactobacillus rhamnose*, *Lactobacillus fermentum*, *Streptococcus thermophilus*, *Streptococcus faecium, Lactobacillus sporogenes*, *Bacillus subtilis*, *Bacillus licheniformis* and *Saccharomyces boulardii*

Mode of Action of Bacterial Probiotics

Probiotics may have:



(1) antimicrobial,
(2) immunomodulatory,
(3) modifier of digestion and metabolism,
(4) antidarrheal,
(5) antiallergic,
(6) antioxidant and
(7) anticholesterolemic effect.

Mechanism of Action in Detail

Antimicrobial effect/Reduction in amount of pathogenic gut microorganisms

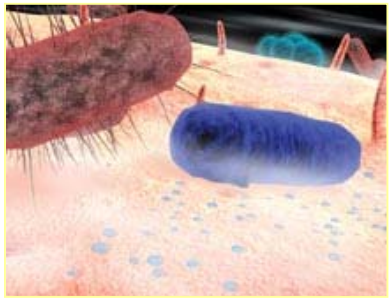
Due to stress or disease or any other reasons when microbial balance swings in favour of pathogenic microorganisms and different disorders (mostly gastrointestinal disorders)/problems arise or are about to arise, probiotic microbial inoculation is prescribed due to its antimicrobial activity. This concept is based on principle of 'competitive exclusion' (Rutz) and known as 'microbial population manipulation (Metchnikoff, 1907).

The operational mechanisms of LAB remains to be exactly defined but some theories put forward (Rutz, 1999).

Production of antimicrobial compounds

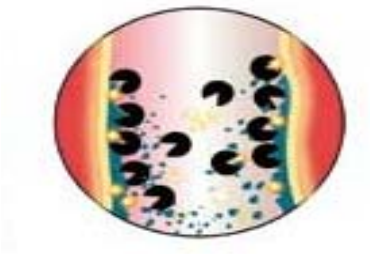
These substances are known as bacteriocins. Such a bacteriocin has been isolated from *Lactobacillus plantarum* ST-31, it is a 20 amino acid peptide. A different bacteriocin was isolated from another strain of *Lact. plantarum* – it was a 27 amino acid peptide with a lanthionine residues – this type of bacteria is classified as lantibiotic.

Production of antibacterial metabolites



LAB produce metabolites like hydroxyperoxides and organic acids such as the lactic acid and VFA which leads to reduction of pH in intestine and thereby prohibition of growth of pathogenic microorganisms and ameliorating LAB growth.

Competition for nutrients



Competition for nutrients like available carbohydrate between favourable and unfavorable microorganisms. Also it normalises previously abnormal intestinal permeability.

Competitions for sites of attachment on the intestinal wall

Attachment on the intestinal wall ameliorates proliferation as well as reduces peristaltic removal of organisms. Most of the enteric pathogenic agents, such as *E. coli* needed to attach on the intestinal wall to develop disease (Weinack *et al*., 1982) and attachment is probably due to attraction between acidic mucopolysaccharides forming outer layer of bacterial cell wall and similar coating on epithelial cells. Fibrils present in bacteria also help in attachment. LAB attach and colonize on intestinal wall preventing pathogenic bacteria to flourish. By this process, Lactobacillus eradicate *E. coli, Bifidobacterium breve, Campylobacter jejuni* (causing enteritis), Lactobacillus GG eradicate *Clostridium difficile* (causing relapsing colitis), *Bifidobacterium bifidum* and *Streptococcus thermophilus* reduce rotavirus (cause of infant diarrhoea).

Enterotoxin neutralization: *L. bulgaricus* in pigs produces some metabolites that can neutralize the effect of enterotoxins. Lactic acid bacteria inhibits the growth of coliforms and production of toxic amines by it (Mitchel).

Thus, by these antibacterial mechanisms, LAB potentially prevents growth of pathogenic bacteria, such as *Salmonella* sp. (Lloyd *et al*., 1977), *E. coli* (Weinack *et al*., 1982), *Campylobactor fetus*, *Streptococcus thermophilus, Clostridium perfringens* (Anons, 1980), *Salmonella entridies* in pigs and poultry (Bechman *et al*., 1977).

Modification of Metabolism and Digestion

- **Increase of enzymatic activity**: It increases the activity of beta-galactosidase which decreases lactose tolerance and increases digestion of lactose.
- Some literature demand that it increases lactase, lipase, peptidase activity, prevents de-amination and production of more bile acids. Thus, utilization and digestion of carbohydrate, protein and fat increases.
- LAB increases bioavailability of Ca, P, Mg and Zn from all diets. Ca and P availability increases by 7 to 9 per cent.
- Decrease of enzymatic activity (for example beta-glucoronidase, nitroreductase and azoreductase).

Immunomodulatory effect

By specific and non-specific activation of immune system (Hill *et al*., 1986). *L. casei* stimulation of immune system increase concentration of circulating TGA in rotavirus infection.

1. Probiotic also increases concentration of IgG and higher number of antibiotics.
2. Higher macrophagic activity also suggested.
3. *L. acidophilus* and *B. bifidum* appear to enhance non-specific immune phagocytic activity of circulating blood granulocytes.
4. In healthy animals, *L. salivarius* UCC118 and *L. johnsonii* LA1 were demonstrated to produce an increase in the phagocytic activity of peripheral blood monocytes and granulocytes.
5. *L. GG* potentiate intestinal immune response.
6. *L. johnsonii* LA1 was found to increase the frequency of interferon-gamma producing peripheral blood monocytes.
7. Increase in WBC activity also suggests there is increase in WBC content in *L. acidophilus* inoculated pigs.

Antidiarrheal effect

The cases of scouring of pre- and post-weaned pigs reduced to almost 52% by feeding 4 to 5 x 10^5 cfu of lactobacilli per day depending upon the body weight of piglets (Apgan *et al*., 1993). This is possibly by (1) Normalization of previously abnormal intestinal permeability, and (2) eradication of diarrhoea producing organisms, such as enteropathogens – *E. coli, Salmonella typhimurium, Staphylococcus aureus* and *Clostridium perfrigens* by microbial population manipulation.

Anticarcinogenic effect

1. 2-6 fold reduction of activity of marker enzyme related to cancer – beta-glucorunidase, nitroreductase and azoreductase after 4 week supplementation of 10^9 to 10^{10} viable cfu *L. acidophilus*. These bacterial enzymes produce proximal carcinogens from procarcinogens in lower intestines.

2. Lactobacilli inoculation specifically reduces the risk of colon cancer in animals (Friend and Sahani, 1984).

Antiallergic effect

Probiotics that colonize in intestines of pig and calves may be helpful in management of some food allergies by reinforcing the barrier function of intestinal mucosa.

L. GG and *B. lactis* BG-12 reduce concentration of circulating CD4 + T lymphocytes and an increase in transforming growth factor beta-1 (TGF beta1) indicating suppressive effects on T-lymphocytes and restore TG1/TG2 balance in atopic eczema and food allergies.

Antioxidant effect

Lactobacillus GG was found to scavenge superoxide anion radicals, inhibit lipid peroxidation and chelate Fe *in vitro*. Fe-chelating property may account for antioxidant activity. Other LAB including strains of *L. acidophilus, L. bulgaricus, B. longum* and *Str. Thermophilus* have demonstrated antioxidative ability. Mechanisms include chelation of metal ions (Fe, Cu), scavanging of reactive oxygen radicals and reducing activity.

Anticholesterolaemic effect

Several LAB have shown to be capable of hydrolyzing bile acids, which would prevent reabsorption in the intestine and facilitates elimination from the body. Bile acids are formed from cholesterol in the liver and, therefore, any increase in elimination of bile acids from body would increase the rate of conversion of cholesterol to bile acids – eventually decreasing the blood cholesterol level.

CONCLUSION

From the overall discussion, it is clear that probiotics are positively increase feed utilization, meat production and immunity of animal and decrease feedintake per kg BW gain, harmful bacterial load and thus chances of disease.

So, judicious use of these results in improved productivity and profit in a farm or to a farmer. But certain facts should be kept in mind while using probiotics. Use of these may be of no use in over coming the development of antibiotic resistance (Lyons, 1987) and also they could not replace antibiotic in treatment of disease. They are only used as prophylactic measure.

Also faulty management practices and insufficient/ low quality feed will not produce the desired result. Because probiotics appear to have more pronounced effect on farm where housing are not optimal (Mulder RWAW et al., 1997). Therefore, probiotics must be considered as a potential element in a feeding and management system of pig production without the use of antibiotics as feed additives.

For Further information please refer to our Product details of:

- **e-microbes**
- **Spectra-DFM**
- **SpectraSol-DFM**

REFERENCES

Fuller R (1989) Probiotics in man and animal- A review J. of Appl. Bacteriol.66: 335-342

Mulder RWAW, Heavenaar R, Huis J H J and Fuller R(1997) Probiotics-Applications- and-practical-Aspects pp 187-207

Abe F, Ishibashi N and Shimamura S (1995) Effect of administration of Bifidobacteria and Lactic acid bacteria to newborn calves and piglets. J. Dairy science 78(12) : 2838-2846.

Faieyildman, Robert E.C. (2001), Handbook of neutraceuticals and functional foods. CRC Press. Pp. 407-422.

Cho K H, Lee U T, Yang C K, Yu I W, Kim Y S and Yoon Y D (1992) Ther effect of Lactobacillus casei(TSC-66) for growth promotion in piglets. Korean J. Vet. Pub.health 16(1); 49-53.

Bomba A, Gancarcikova S, Nemcova R, Herich R , Castel R, Depta A, Dameterova M, Ledecky V and Zitnan R (1998) The effect of Lactic acid bacteria on intestinal metabolism and metabolic profiles of gnotobiotic pigs. Dueet tierarzt wochen 105(10): 384-389.

Tkachev E J and Gvyzien O L(1995) Digestive and metabolic functions of the gastrointestinal tract of piglets.Russian Agr.sci 4: 8-11

Tortuero F, Rioperez J, Fernandez E and Rodriguez M L (1995) Response of piglets to oral administration of Lactic acid bacteria. J. Food product 58(12): 1369-1374.

Adami A and Cavazzoni V (1999) Occurrence of selected bacterial groups in the faeces of piglet's fed with bacillus coagulence as probiotics. J. Of. Basicmicrobiol 39(1): 3-9.

Vassalo M, Fialho E T, Oliveira A I G de, Teixeira A S and Bertechini A G(1997) Probitics for piglets from 10-30 kg live weight- Rev Socied brazil zootech 26(1): 131-138

Breves G, Walter C, Burmester M and Schroder B (2000) Invitrostudies on the effects of Sachrromyces boulardii and Bacillus Cereus on nutrient transport in Pig jejunum. J. Of . Animal physiology and Animal Nutrition 84(1-2): 9-20

Anderson D B, Mac cracken V J , Aminov R I, Simpson J M, Mackie R I, Verstegen M W A and Gaskins H R (1999) Gut microbiolovgy and growth promoting antibiotics in swine. Pig News inform. 20(40): 115N-122N

Pollmann D S, Danielson D M and Deo Jr E R(1980) Effect of Lactobacillus on starter pig fed a diet supplemented with lactose J. of . Animal Science (51): 638

Genovese K J, Anderson R C, Harvey R B and Nisbet D J (2000) Compatitive exclusion treatment reduces the m,ortality and Faecal shedding associated with E.coli infection in nursery- rised neonatal pigs. Canadian J. Vet. Res 64: 204-207

Pollmann D S, Danielson D M, Wren W V and Deo Jr E R (1980) Influence of lactobacillus acidophilus on gnotobiotic and conventional pigs J. of . Animal Science (51): 629

Kornegay E T, Rhein welker D, Linderrmann and Wood C M (1995) Performance and Nutrient digestiblity in weanling pigs as influenced by yeast culture addition to strster dtiet containing dtried whey or one of two fibre source. J.of.Animal science 73:1381-1389

Bullriss, J. and Saltmarsh, M. (2000). Function Foods. II. Claims and evidences. Royal Society of Chemistry. pp. 61-108.

Goldberg Israel (1994). Functional Foods. Chapman & Hall, pp.294-322.
Clerke, E.C. Applied Nutrition. Chapter on Probiotics and Prebiotics.

Lyons, T.P. (1990). Biotechnology in the Feed Industry : Proceedings of Alltech's Fifth Annual Symposium. Alltech Technical Publications, pp.35-85, 139-148 and 261-270.

Improving Nutrient Utilization while Reducing Pollution: New Dimensions through Biotechnology. Asia Pacific Lecture Tour. August 17-28, 1992. Alltech Inc. pp.. 15-38, 125-132 and 147-158.

Lopez, J. (2000) Probiotics in animal nutrition. Asian-Aust. J. Anim. Sci., 13 (Spl. issue): 12-26.

Xuan, Z.N., Kim, J.D., Jung, H.J., Heo, K.N., Lee, J.H., Han, Y.K., Kim, Y.Y. and Han, K. Jr. (2001). Study on development of a probiotics complex for weaned pigs. Asian-Aust. J. Anim. Sci., 14(10): 1425-1428.

Mosenthin, R. and Bauer, E. (2000). The potential use of prebiotics in pig nutrition. Asian-Aust. J. Anim. Sci., 13: 315-325.

Cinvex, Vol. 2 (2001). Issue J. VET ads publications, Kerala. pp. 241-285.

Latha Sabikhi nee K.K. Latha K. (1999). Biotechnological studies on the enhancement of probiotic attributes through *Bifidobacterium bifidum* in Edam cheese. Ph.D. Thesis, NDRI, Karnal. pp. 18-26.

Ruchi Kushal (2001). Studies on the effect of microentrapped co-culture of *Lactobacillus acidophilus* and *Bifidobacterium bifidum* on the inhibition of enteropathogens. pp. 5, 9, 12-17.

Mishra Vijendra (2001). Studies of probiotic attributes in selected strains of *Lactobacillus casei*. Ph.D. Thesis, NDRI, Karnal. pp.14-25