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PROBIOTIC FERMENTED SAUSAGES

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ABSTRACT

Depending on the rate of pH drop, heating process, final moisture, shape and way of manufacture, probiotic fermented sausages are classified into some categories including; Fast, intermediate, slow or Moist "10% weight loss", semi- dry "20% weight loss", dry "30% weight loss" or sliced, spread or European and American fermented sausages. Since European fermented sausages are produced by drying at 22-26 °C rather than acidification, they may develop an improved flavor, whereas American fermented sausages are mostly produced by rapid fermentation and metabolite production by lactobacillus *plantarum*, *pediucoccus acidilactici* and starters resistant to more than 40 °C temperatures. In addion to analyze the technology of probiotic fermented sausages manufacture, the objective of this study was to provide new ideas for producing such products using research records on probiotics.

Keywords: Fermented sausage, probiotic, meat product, fermented.

INTRODUCTION

Fermented sausages have originated from Mediterranean region. This product was savory to Romans and had an extended shelf life. In 1998, probiotic meat products were produced in Germany and Japan. This product now is the most widely used in Germany, Italy, Spain and France. Manufacture of this product has been always profitable for manufacturers; however, it is better for patients, the elderly, pregnant, and children to consult with a physician before using probiotic products. In general probiotic fermented sausages may be defined as a cased mixture of meat flavorings, sugar, salt, seasonings, bacteria culture media made through

fermentation, drying and curing processes (12).

2. Steps of manufacturing probiotic fermented dried sausages

2.1. Preparation, weigh, mixing and filling

2.2. Conditioning

2.3. Fermentation ripening step

2.4. Smoking ripening step

2.5. Drying ripening step

2.6. Packaging

2.7. Storage

The above steps are discussed in the following sections (13, 17).

2.1. Preparation, weigh, mixing and filling: Given the following classification of bacteria, providing safe conditions, i.e. favorable conditions for promoting the growth of useful bacteria and preventing spoilage bacteria from growing is crucial:

A. The activity of spoilage bacteria is associated with changes in organoleptic properties of foods.

B. Pathogenic bacteria are harmful causing morbidity even without any effect on smell, flavor, and texture of foods. *Staphylococcus Aureus* with water activity "aw" of 0.89 and tolerance to pH 5.2 is included in this group.

C. Useful bacteria have various functions as micrococcus *Staphylococcus Xylosus*, *S. Carnosus* convert nitrate into nitrite playing role in preservation and color development. In addition, *Micrococcus* may improve the flavor of product. *Pediococcus* and *Lactobacillus* produce *Lactic acid* thereby increasing the acidity (17).

2.1.1. Hurdles to spoilage in meat products

- Meat pH drop: while pH drop in digestive system may not be sufficient for inactivation of harmful bacteria in fermented sausages new techniques minimize the risk of contamination caused by *E. Coli* in fermented sausages.

- Use of clean tools, hygienic conditions and fresh cold meat with low microbial load "100-1000/g": molds decompose *Lactic acid* during ripening thereby increasing pH value and reducing acidic flavor. Some culture media produce some antibiotic for controlling *Loconostoc Monocytogenes* to a safe non – pathogenic level called *Pediocine* and *Bavaracine*.

- Smoking and cooking

- Reducing water activity by drying: *Staphylococcus Aureus*, with aw of 0.89 is the indicator *bacterium*. At this stage 10% saline solution is required however addition of more than 3% salt causes saltiness.

- Curing by use of sodium nitrite or sodium nitrate: some salts provide a preservative effect. Salt and sugar reduce aw competing with bacteria. However it is better to use long drying to rduce aw because nitrite diminishes the number of *Lactic bacteria* (17).

- Spoilage preventing flavorings (8,17).

Table 1: Water activity of foods "bacteria do not grow at a level lower than their specific water activity"

Water activity of some foods	
Pure water	1.00
Fresh meat and Fish	0.99
Bread	0.99
Salami	0.87
Aged Chedar	0.85
Jam and Jellies	0.80
Plum pudding	0.80
Dried Fruit	0.60
Biscuits	0.30
Milk Powder	0.20
Instant Coffee	0.20
Bone Dry	000

Source: 2015, meat and sausages, USDA guidelines state

Table 2- Water activity of some spoilage microorganisms microbes do not grow at a level lower than their specific water activity

Microbial Group	Example	aw	Products affected
Normal Bacteria	*Salmonella Species,* *Escherichia Coli* *Clostridium Botulinum* *Staph, Aureus*	0.95- 0.93 0.91 0.89	Fresh meat, milk Animal intestinal tracts, Unchlorinated Water Meat, Soil Skin, Red Meats, Poultry
Normal Yeast	*Torulopsis Species*	0.88	Fruit Juice concentrate
Normal Molds	*Aspergillus Flavus*	0.80	Jams, Jellies
Halophillic Bacteria	*Wallemia Sebi*	0.75	Honey
Xerophilic Molds	*Aspergillus Echimulatas*	0.65	Flour
Osmophilic Yeast	*Saccharomyces Bisporus*	0.60	Dried Fruits
Source: 2015,meat and sausages ,USDA guidelines state			

2.1.2. Additive s to probiotic fermented sausages

2.1.2.1. Spoilage – preventing flavorings

Glocono Delta lacton "GDL": Is a natural acid**.** Addition of 10 g of GDL may develop a bitter and acidic flavor. Use of 0.1% GDL cause a 0.1 decrease in pH, and each 1 g of GDL metabolizes 1 g of sugar (17).

Citric acid: Is a natural preservative. It is three times more acidic than GDL thus its use is more limited (17).

Sugar: Is a food source for starter culture and reduces aw (17).

Dextrose: a diglucose is the selective sugar for rapid fermented sausages. It is directly converted into lactic acid when fermented. Each 0.1% dextrose causes a 0.1 decrease in pH value of the product (17).

Sucrose: Saccarose or common sugar extracted from sugarcane and sugar beet. It develops better flavor and color in slow fermented sausages because fast pH drop is not required. In intermediate fermented sausages, a combination of sucrose and GDL is used (17).

Maltose: Is used to balance acid-flavor and reduce Aw. It is found in grains, sprouts and cereals (17).

Lactose: Or milk sugar is found in milk at a concentration of 2-8%.

In general, lactose and maltose are less important however, when they are used together with common sugar result in an excellent flavor. The most important inhibitors of spoilage in rapid and intermediate fermented sausages are Glucono Delta Lacton, citric acid and sugar and in slow fermented sausages are reduced moisture due to prolonged drying (17).

Seasonings: Antimicrobial activity of essential oil of orange "D-limonen 94% and miercine 3%" cinamaldehyde of cinnamon, caroacrole of thyme and menthe ogenole of clove, capcisine of chili, and allyle sulfur compounds found in garlic oil (8,17).

2.1.2.2. Carboxy methyl cellulose "CMC" and microcrystalline cellulose "MCC"

Both compounds are dispersed in the structure of fat particles. CMC causes significant changes in the structure of heated meat paste however it considerably reduces viscoelasticity and hardness of meat paste from the beginning and after heating. MCC develops a little variation in the structure of heated meat paste increasing its hardness (31).

2.1.2.3. Probiotics: Are useful living microorganisms exerting healthful effects on immune system because of having bactericine effect competing with harmful microorganisms existing in intestinal mucus, and balancing useful and harmful bacteria (4). For example streptococcus thermopiles produce enzyme β-galacosidase being beneficial for lactose – intolerant patients (4,7). Probiotics function in three ways: First by inhibiting the viability of harmful organisms through producing antibiotic compounds or competing for food and/or attachment compounds; second by microbial metabolism modification increasing or decreasing enzymatic activity; third, by stimulating immune system increasing the level of antibody, or enhancing macrophage activity (7). Survival and activity of probiotics depend on prolonged ripening, formulation high – temperature drying, fermentation and acidity of digestive system "pH<5". Thus manufacture of raw fermented meat product is more reliable than that of cooked product (13). The probiotic is selected besed on safety measures applicable measures survival and technological indicators (29, 13). Extended shelf – life type and number of probiotics fast growing during fermentation maintained effectiveness under unfavorable conditions i.e. aw < 85% and pH <5 when digested for 2-4 h, as well as promotion of organoleptic and healthful properties in meat products are effective in formulation and production line design (13). WHO and

FAO have stated that these microorganisms have to be in sufficient amount viable and exert useful physiological effects (19). FAO has included these qualities in dietary supplements. Navarro; Spinoza *et al*., (2008) stated that the required number of probiotics to provide health benefits was 10^9-10^{10} CFU/g and that 10-100 g of fermented product contained 10^8 CFU probiotic cells. Probiotic culture media are prepared as concentrated or lyophilized. Lyophilized cultures dried by freezing result in delayed fermentation and diminished efficiency. Microencapsulation before lyphilization could overcome this problem thereby improving the bacterial efficiency by the bacterial cells. Probiotics encamsulation is perfomed by using alginate starch κ-carrageanan, guar gum, xanthan gum gelatin and whey proteins. *Lactic acid bacteria* are microencapsulated via extrusion or emulsification methods. Extruded microencapsulated products with a diameter of 2-3 mm are 60 times larger than microcapsules formed by emulsification (13). Encapsulation is the process of forming a permanent coating around a matrix. Another process immobilization is the entrapment of a substance in a matrix. Immobilizer are non – toxic stable and easily–available showing special properties regarding cost, transferability, biological decomposition as well as physical properties, microbial growth possibility and solubility. Both encapsulation and immobilization are intended to extend the viability of cells and improve their potential effect by entrapment in the matrix, absorption under electrostatic forces or covalent bonds between membrane and carrier, cross–linking and mechanical control by a "hurdle" (19).

Healthful general characteristics of probioitcs:

-Production of conjugated linoleic acid by some probiotics anticancer, antiobesity, antidiabetic and antiaterogenic effects, improving bowl movement and digestion as well as lactose intolerance symptoms promoting immune response, reducing the incidence of diarrhaea, preventing or suppressing colon cancer and lowering cholesterol (13, 1, 15).

-Production of micronutrients by some probiotics (13).

-Production of lactic acid is among the most important characteristics of lactobacillus. Di-lactic acid isomer is not metabolized so it is harmful to the consumer. *Lactic acid bacteria* show greater inhibitory effect on spoilage microorganisms due to lack of the isomer production. Acidification in meat improves flavor and color coagulation of myofibrillar proteins and toughness of product prevents

spoilage caused by pathogenic microorganisms and aggregation of biogenic amines (13).

-Production of enzymes and reduction of biogenic amines: biogenic amines have an organic base with a aliphatic, aromatic or hetrerocyclic structute. Biogenic amines such as histamine, triptamin, tyramin, cadaverin, putrecin, and aspermidin leave toxic effects particularly in consumers lacking aminoxidase. Biogenic amines are generated by microbial decarboxylation of meat amino acids. Prolonged ripening of fermented meat products may increase the amount of biogenic acids produced by microorganisms because of protein content and intense proteolytic activity. Some species of lactobacillus produce amino acid decarboxylas. Also *lactobacillus Plantarm* increasing CD-8 and CD-4 lymphocytes and *L. Casei* shows amine oxidase activity. Turkey fermented sausagtes are low in biogenic amine content (5, 15, 13).

-Production of bacteriocins: bacteriocins ar peptides or proteins produced by microorganisms which inhibit or eliminate gram – positive bacteria notably *Lysteria Monocytogenes*. Bacteriocins are natural non–toxic preservative exerting bacteriostatic or bactericidal effects, thus they are harmless to consumer's health and product safety lactic acid bacteria including *lactobacillus Sakei*, *L. Curvatus*, *L. Plantarum*, *L. Brevis*, and *L. Casei* produce bacteriocins (2). Dried fermented sausages provide a favorable environment for *L. Sakei LTH 673*, a producer of bacteriocin Sakeicin P. This heat–resistant bacteriocin inhibit pathogenic *Enterococcus Facalis* and *Lysteria Monocytogenes* (33).

-Autoaggregation property: Demonstrates the attachment of probiotics to intestinal epithelial cells (8, 13).

-Coaggregation property: Inhibits pathogenic microorganisms capture. Probiotics show inhibiting and competitive effects on pathogens (13).

-Being tolerant to 2-3% salt and 120 ppm nitrite (13).

Selection criteria for probiotic to be used in meat product:

-Ability of hydrolyzing biliary salts (4), resistance to gastric acidity, lysozyme and bile. Biliary salts decompose fatty acids present in cell membrane of microorganisms exerting an inhibitory effect on them. Some *Lactobacillus* species produce hydrolase being able to hydrolyze biliary salts and weaken biliary detergent strength (7, 13).

-Ability of capturing human intestinal system by attachment to intestinal epithelial cells (13). Research has shown that the number of residue *Bifidobacteria* in intestines decreases with aging (23).

-Being tolerant to pancreatic enzymes.

-Being GRAS, non – toxic, use ful and healthful (7, 13).

-Having antagonistic and antimutagenic properties and antibiotic resistance (29). Antibiotic resistance has been recognized as crucial by European food safety authority "EFSA". *Lactic Acid Bacteria* "*LAB*" are naturally sensitive to penicillin, ampicillin, tetracycline, erythromycin, cloramphenicole, as well as aminoglycosides, coinolones, and glycopeptides. Thus genetic transfer of resistance ability to some antibiotics "cloraphenicole, erythromycin and tetracycline" to other bacteria has been considered (29).

-Ability of oxidizing the composed biogenic amines (13).

Table 3- Starter cultures applicable in fermented meat products

Genus/species "a. probiotic medium; b. commercial; c. micrococspecies"	Starter microorganism
Lactobacillus acidophilus a, L. alimentarius b, L. brevis, L. casei a, L. curvatus, L. fermentum, L. plantarum, L. pentosus, L. sakei Lactococcus lactis, Pediococcus acidilactici, P. pentosaceus	*Lacticacid Bacteria*
Kocuria varians c, Streptomyces griséus, Bifidobacterium sp. A	*Actiobacter*
S. xylosus, S. carnosus subsp. carnosus, S. carnosus subsp. utilis, S. equorum b	*Staphylococcus*
Halomonas elongata b "it has been tested in dried cured hamburger because of toterance against specific conditions"	*Halomonad* family
Aeromonas sp	*Enterobacter*
Penicillium nalgiovense, P. chrysogeum, P. camemberti	*Mold*
Debaryomyces hansenii, Candida famata	*Yeast*
Source: Macedo, R. E. F., S. B, Pflanze., C. L, Gomes. 2012. Probiotic meat products. Probiotics in animals. INTECH. Brazil. (5): 87.	

Other additives: Various types of cheese, flour, preservatives, phosphate, soy protein, emulsion, starch, dextrin, maltodextrin, gums, pectin, cellulose, and oils (17, 18, 25).

2.2. Conditioning: Temperature of grinding, mixing and filling. Cold sausages are kept in warm fermentation room for 1-6 h depending on the diameter of product. Despite drying of product surfaces, elimination of this step is optional. Rapid conditioning and drying reduce the content of moisture required by *Lactic Bacteria* on the surface thereby preventing increased acidity and changed color of the product. For fermented sausages, conditioning is carried out for < 6 h at 20-25C, humidity <60% , aw 0.96-97 and pH of 5.8 (17).

2.3. Fermentation: Fermentation is generally applied at 18-26C, current speed 0.8 m/s, humidity of 92-95% depending on the type of fermentation resulted from the used starter culture. For slow fermented sausages, humidity 92-98%, aw of 95% fpr 2-4 d are provided. As lactic acid production occurred in this step, pH drop to 5.2-5.6 and consequently improved organoleptic properties are resulted. It

should be noted that aw needs to be 5% higher than the dryer humidity (17).

Table 4- Fermentation temperature for commercial lactic acid bacteria

Name	Temperature range in °C
Lactobacillus curvatus	22 - 37
Lactobacillus farciminis	22 - 32
Lactobacillus plantarum	25 - 35
Lactobacillus sakei	21 – 32
Pediococcus acidilactici	25 – 45
Pediococcus pentosaceus	20 – 37
Source: Chr. Hansen, 2015,meat and sausages ,USDA guidelines state http://www.meatsandsausage.com	

2.4. Smoking:

Types of smoking

-For raw semi-dried as well as slow fermented sausages, cold smoke is used alternately with drying at 18-22 ˚C and 70-80% humidity and good conditioning since continuous smoking develop a bitter flavor. This method is supported in Europe and cold climates due to development a better taste.

-For cooked semi-dried fermented sausages , warm smoking is done at 25-50 ˚C.

-For cooked sausage, the temperatures of 68-71 ˚C or 60-80 ˚C are used. In industrial operation, soot and fat are removed by hot and then cold rinsing. Cold rinsing prevents surface wrinkles (16, 17).

Time of smoking: Smoking after fermentation may develop molds, thus, rinsing and re – smoking smoking at early fermentation step prevents desired and undesirable bacteria from growing because of phenolics, carboxyls, acids, etc. Contained in smoke (1, 16, 17).

2.5. Drying: To prevent case hardening the product must be dried slowly case hardening caused by fast drying prevents the moisture form exiting the product so some cracks develop in the case. Uneven current at this stage moves the residue moisture and air. Air velocity increase as the used temperature is raised (17). The rate of aw decrease and drying in high – fat sausages is greater than low fat ones because the higher fat content the lower meat and water contents (17, 18). Fermentation and safety of product are affected by inhibition of LAB requiring water for growth. For rapid fermented sausages, drying and air velocity are of little importance, whereas pH value is important (17).

2.6. Packaging: Hygien of people, tools, environment and packaging must be performed (17).

2.7. Storage: Short time storage in dark at 10-15C and 75% humidity prevents fat

racidity and changes in color of product (17).

Table 5- General comparison of three types of fermentation: rapid, intermediate, slow

Slow fermentation	Intermediate fermentation	Rapid fermentation
A product with high quality and better taste is produced. Since this product is not completely acidified it develops an acidic pungent flavor. Prolonged drying allows natural reactions inside meat thereby generating a desirable color in the product. Principle: drying process Slow pH drop to ~ 5.5, moisture reduced to 75-80%, air velocity of 1 ft/s and fermentation temperature of 16-20C for more than 4 weeks results in greater decrease in weight. The final product has aw of 0.88-0.89 and pH of 5.3-6. Manufacture method diameter and fat content are effective factors. In this product alternate cold smoking is used for drying. Use of saccharose given good results. Sodium nitrate or sodium nitrite and nitrate are added. There is enough time for *Micrococcus Bacteria* to react with nitrate. Nitrate thus release nitrite required to control *Clostridium*. Addition of nitrate improves flavor, color, and controlling *Clostridium Botulinum*.	It produces a product with higher quality better taste and less acidic flavor as compared to rapid fermented sausages. Principle: intermediate pH drop to < 5 within 4 days given good results by use of saccharose together with GDL. The product is manufactured within 4-6 weeks. In drying step, moisture content reaches85-90% within 5-10d aw of product reaches 0.93 , air velocity0.5m/s pH4.8and temperature reaches 22-25C. As rapid fermentation process, sodium nitrite is used as the first inhibitor of spoilage bacteria because of short–time production.	The product made by rapid fermentation is more inexpensive of poorer quality with the shortest shelf-life and an acidic and pungent taste when compared to the products made by intermediate and slow fermentation. Principle: rapid pH drop to a constant value of < 5 within of <2 days is mainly caused by addition dextrose or GDL to starter culture since there is no sufficient time for moisture movement by controlled drying. Water activity is the least effective parameter against spoilage bacteria thus it is not considered principle. Drying and air velocity are insignificant. Primary fermentation temperature reaches 26-30C and even >45C in very fast cultures. Aw of the final product is ~ 0.92 and pH value is 4.6-4-8. Sodium nitrite is considered the first inhibitor of spoilage bacteria, since nitrate is not utilized when there is not sufficient time for releasing nitrite.

Source: Chr. Hansen, 2015,meat and sausages ,USDA guidelines state http://www.meatsandsausage.com

3. RESEARCH RECORDS

Due to high financial and time costs the fewest in vivo studies have been conducted by local committees “associations; boards; commissions; research missions”. the most studies have been carried out on probiotics survival in meat and their effects on technical and sensory attributes as well as inhibitory property against pathogens and enhancing the safety of meat products (13).

Heidbach e*t al*., (2009) found greater survival of *Lactobacillus F19* encapsulated with caein over frozen storage as compared to *Bifidobacterium Bifidom 12*. They also demonstrated improved survival of both species microencapsulated with gelatinous milk rennet in 2010 (9).

Poulin *et al*., (2011) invented succinylated compact β- lactoglobulin tablets for in vitro and in vivo storage of *Bifidobacterium Longum* (27).

Petaja; Erikkila *et al*., (2000) demonstrated the survival and resistance of *L. Pentosus, LAC. Sakei*, *PED. Pentosus* and *PED. Acidilactici* to pH values of 4 and 5. They also demonstrated that initied number of

*PED. Acidilact*ici and *LAC. Curvatus* showed 1 log decrease when grown in a media containing 0.3% bile salts at pH 6 for 4 h (6).

Pennacchia *et al*., (2004) observed the survival of some *LAC. Casei* subspecies used in dried sausage at pH 2.5 for 3h. they also demonstrated the survival of some species of *LAC. Paracasei* and *LAC. Rhamnosus* isolated from infant feces at low pH (26).

Sameshima *et al*., (1998); Arihava et al., (2000) deemed the addition of 3% NaCl and 200 ppm sodium nitrite to fermented sausages necessary and introduced the curing–resistant media as the first requisite for manufacturing probiotic sausages. They also demonstrated the tolerance of *LAC. Casei* and paracasei as well as *LAC. Rhmnosus* and *LAC. Acidophilus* to these salts (24).

Macedo *et al*., (2005) showed the resistance of *LAC. Rhmnosus, LAC. Paracasei* and *LAC. Casei* to addition of 3% NaCl and 20 ppm sodium nitrite simultaneously. They also found *LAC. Paracasei* resistant to 0.3% bile salt (13).

Pennacchia *et al*., (2004); Erkkila et al., (2005) found mean concentration of bile salts in human intestine as 0.3% being the same as critical concentration tolerated in probiotics (13).

Ammor *et al*., (2000) found a great deal of folate "vitamin B_{11}" produced by genetically modified *Lactobacillus* (2).

Klingberg *et al*., (2005) showed greater ability of *PED. Pentosaseus, LAC. Pentosus,* and *LAC. Plantarum* to aggregate in human gut as compared to *LAC. Rhamnosus* (11).

Kundakci *et al*., (2011) found low content of biogenic amine in turkey fermented sausages by suing any of three probiotic starter cultures of *LAC. Casei* or *LAC. Acidophilus* or their combination (13).

Nowroozi; Mirzaii *et al*., (2004) tested 28 species of *Lactic Acid Bacteria* for antimicrobial activity of which only *LAC. Acidophilus, LAC. Plantarum, LAC. Delbruckii,* and *LAC. Brevis* produced a bacteriocin–like substance. Antimicrobial acitivity of bacteriocin was eliminated by trypsin however it was not affected by α-amylase were eliminated by autoclaving. Maximum bacteriocin amount was obtained at 25C and pH: 6.5. MRS Broth must contain at least 1-2% glucose or xylose. Addition of 1% NaCl to MRS medium increases bacteriocin production. Antimicrobial activity is at max. level at early stationary phase and remains constant even after suppressed parent cells growth (22).

Joerger; Maenhammer *et al*., (1989) found bacteriocin helvetican in *LAC. Helveticus* $_{481}$ as 37 KD (3).

Rammelsberg; Radler *et al*., (1990) found bacteriocin caseicin B_{80} sized 42 KD in *L.casei* (3).

Tobaetd *et al*., (1991) found bacteriocin A in *LAC. Acidophlus* $_{PT\ 1060}$ (3).

Sameshima *et al*., (1998) found *LAC. Rhamnosus* $_{Fp\ 15120}$, *LAC. Paracasei* inhibiting growth and toxicity of *Staph. Aureus* in meat product (28).

Khaledi (2014) found Iranian oak fruit flour inhibiting gram–positive bacteria, some yeasts, and molds in flat bread. He evaluated the limited applicability of Iranian oak fruit flour as natural preservative in unfermented products such as unfermented meat products (10).

Sayas *et al*., (2012) stated that adition of *L. Casei* $_{CECT\ 475}$ to a Spanish sausage dried and cured in a traditional manner named longaniza de pascoa could accelerate drying and that addition of 1% orange fiber improves growth and survival of *lactobacillus* and *Micrococcus* thereby promoting microbial quality and safety of sausages (30).

Verma *et al*., (2009) recommended the use of dietary fiber in meat products because meat is free from dietary fiber. Dietary fiber provides healthful benefits including prevention from cardiovascular disease cancer, diabetes type 2 and obesity depending on its origin "grains, fruits, vegetables".

Yusekday et al., (2009) showed the auto aggregation ability of most exopolysaccharides produced by two species of *PED. Pentosaseus* $_{z12p}$, $_{z13p}$ isloted from turkey fermented sausages as compared to other *Pediococcus* species islolated from the same product. Co aggregation desirability of *Pediococcus* species and *Lysteria Monocytogenes* $_{ATCC\ 7644}$ was in the following order; z12>z13>z9>z10>z11 (35).

Mahoney et al., (2006) found *PED. Pentosasus Stap. Xylosus, Bifidobacterium LAC. Acidophilus* and *LAC. Paracasei* inhibiting *Lysteria Monocytogenes* in murine digestive system (14).

Muthukumarasamy *et al*., (2006) reported that microencapsulation of *LAC. Reuteri* $_{ATCC\ 55730}$ had no effect on sensory quality of probiotic meat product despite the fact that panelists perceived it similar to fat particles for color and size. This *LAC. Reuteri* and *B. Longum* $_{ATCC15708}$ did not show any inhibitory effect on *E. Coli* $_{H7:0157}$ (20).

Nedelcheva *et al*., (2012) found *LAC. Plantarum* $_{NBI\ MCC}$ inhibiting *E. Coli* $_{ATCC\ 25922}$ and $_{ATCC\ 8739}$, *Proteus Vulgaris G, salmonella Aboni* $_{NTCC\ 6017}$, *Stap. Aureus*

ATCC 25093, *Stap. Aureus ATCC 6538p* and *Lysteria Monocytogenes* at 15-18C (21).

Shelata *et al*., (2012) found *LAC. Plantarum* inhibiting *Stap. Aureus* and *E. Coli* demonstrating the inhibitory effect of *Lactobacilli* on aerobic and anaerobic microorganisms (32).

4. CONCLUSION

Probiotic *PED.Acidilactici*, *LAC.Casei*, and *LAC.Paracasei* have empirically shown good properties in fermented sausages. Some species of *Bifidobacterium* and *lactobacillus* as well as some species of *Lactococcus* and *saccharomyces* are most widely used probiotics in meat products. As shown in table 4 *PED.Pentosaceus* being tolerant to 20C would be more easily applied. *PED.Acidilatitci* is able to tolerate up to 45C it is possible to improve physicochemical properties and healthful effects by using other probiotics orange fiber, prebiotics , vegetables, seasonings and genetically modified probiotics used in probiotic fermented sausages. Thus consumer's acceptance and innovation in manufacture of meat products may promote human health.

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