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## Quality of fermented foods

Fermentation is, with drying and salting, one of the oldest methods for food preservation. Fermented foods can represent more than half of the daily diet of rural and urban populations in many countries in the world. The processes participating to the elaboration of the quality of fermented foods depend on the composition of the raw material and of the indigenous microflora but also of the environmental conditions of the raw material. Generally, pre-fermentative operations allow bacterial species (i) to colonize mainly the environment, (ii) to lead specific biochemical transformations catalyzed by enzymes synthesized in a sufficient quantity and active, (iii) to synthesize macromolecules with antimicrobial activity.

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Fermentation is, with drying and salting, one of the oldest methods for food preservation. Milk and meat were fermented and consumed in Babylon 5000 years ago. In countries where the use of refrigeration and/or appertization are sometimes difficult to implement, fermentation is the preferred method of stabilization of plant and animal productions. In such countries, fermented foods can represent more than half of the daily diet of rural and urban populations. Fermentation ensures food security in Africa: for example, fermented cassava is an important ingredient of diet of more than 800 million people [1]. Fermentation allows the preservation of perishable agricultural raw materials. Fermentation extends the range of agricultural raw materials which can be used for food production from a raw material which is not directly edible. Stabilization is ensured mainly by acidification which occurs during lactic fermentations. Fermentation contributes to preserve and increase the nutritional value of foods by increasing the digestibility of some components such as starch, increasing the bioavailability of some micronutrients such as iron and promoting the degradation of anti-nutritional compounds such as phytates or alpha galactosides [2]. The presence of probiotic bacteria into fermented foods confers a health benefit for the consumers. Manufacturing and consumption of fermented foods are often related to cultural, ethnic or religious preferences. These foods can be described as traditional and identity, some authors describing as ethnic. Tradition determines way to consume and the methods of manufacturing which are empirical, handed down from generation to generation, sometimes only orally. In many countries, particularly in rural or suburban areas, fermented foods are produced at family level, village on a small scale and low cost and are well integrated socially. The fermentation adds some values to the

local agricultural productions and allows the creation of jobs [3]. In many countries, traditional fermented foods suffer from the competition of manufactured fermented foods produced in developed countries at industrial scale. The poor image of traditional fermented foods is because fermentations are led by indigenous strains and are not controlled. The producers of these fermented foods are insufficiently trained on good hygiene practices or have difficulties to apply them. Finally the fermented foods are contaminated by spoilage micro-organisms and/or pathogens which limit their self-life and/or which are risks for the health of the consumers. The processes participating to the elaboration of the quality of fermented foods depend on the composition of the raw material and of the indigenous microflora but also of the environmental conditions of the raw material [4,5,6]. Generally, pre-fermentative operations allow bacterial species (i) to colonize mainly the environment, (ii) to lead specific biochemical transformations catalyzed by enzymes synthesized in a sufficient quantity and active, (iii) to synthesize macromolecules with antimicrobial activity.

The quality of fermented foods is directly linked to the activity of the indigenous microbial flora of the raw material but also of the environment. This microflora is diverse. This diversity can be infra-specific. During the fermentation process, several bacteria species can coexist. Every bacterial species are developing only or in synergy with other species according to the environmental conditions. The fermented foods are complex microbial ecosystems. The activity of microorganisms is influenced by the physical and chemical conditions of their environment like the composition of the raw material more or less modified by the pre-fermentation operations. For numerous fermented foods, the

constitution and the dynamics of microbial populations, physiological properties of the microorganisms and their behavior during fermentation are unknown. These misunderstandings oppose the possibilities of improvement of the processes of manufacturing and selection of bacterial starters. A better understanding of the transformations achieved at each step of fermentation process is essential for the improvement of the quality of the fermented products. To control the quality of the fermented foods, a global approach is chosen by trying to answer totally or partially at the following questions: what strains? Why? How? What profits?

The question "What strains" involves answers on the identity of all the present microorganisms (also spoilage and pathogenic bacteria) and their dynamics during the process.

The question "Why?" involves answers on the properties of present micro-organisms during the fermentations to know what confers them an advantage of growth and activity in front of other present microorganisms.

Answer the question "How?" is to know what are the physical, chemical, microbiological characteristics of the raw material which can be acquired during the pre-fermentation operations occurring during the traditional process of manufacturing which determine directly the structure, the dynamics and the activity of the microflora. The control of each step of the process is thus essential and it requires a good understanding of each of them. The observation of the practices, inquiries, allows to

make a typology of the manufacturing processes which it is then advisable to relate with the characteristics of the finished product. This phase of diagnosis also allows identifying critical points for HACCP. The achievement of challenge tests can inform about the hygiene of the manufacturing process. The use of antimicrobial molecules can be envisaged as well as the implementation of physico-chemical process to reduce the impact of the negative microflora initially present.

The question "What profits?" allows to know if the fermentation leads to the improvement of the hygienic quality and to the stabilization of fermented foods. The stability of the fermented food is based on the increase of their resistance to microbial contaminations. The protection of the fermented food depends mainly on the capacity of the lactic bacteria to produce enough lactic acid and acetic acid but also bacteriocins and hydrogen peroxide. The stability can also be due to the inactivation of enzymatic activities. The benefit can be nutritional like the biosynthesis of vitamins, essential amino acids, proteins. The improvement of the digestibility of proteins and fibers is expected but also a better bioavailability of micronutrients and the destruction of anti-nutritional factors. The profit can be therapeutic associated with the presence of probiotics. The study of the impact of the various steps of the manufacturing process on the final quality can lead to a modification of this one and it is also a benefit by allowing the limitation of production costs or by improving the final quality of the product.

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