



## Milk Quality along the Dairy Chain for a Safe and Sustainable MILK (MILKQUA)

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*MILKQUA is a PRIMA<sup>1</sup> cross-multidisciplinary research project engaging five EU partners from four countries (France, Italy, Spain, and Portugal) who team up with five Tunisian partners representing research, development, extension and farmers. The ambition of the project is to enhance the role of Tunisian dairy producers as providers of sustainable food supply to consumers. Although focused on a partnership with Tunisian actors, the results and spin-offs will be disseminated and exploited in other Mediterranean and southern countries, whose sector locks are widely similar. The research objectives fit perfectly with the philosophy and values of the symposium on the milk sector as a vector of development.*

### **1. Rationale**

Agri-food is one of the most strategic sectors in the Mediterranean area. The region is indeed facing a steady rise in food needs as a direct consequence of rapid population growth and recent changes in consumption patterns. The recent revolution highlighted the urgent need of improving the poor living conditions by increasing employment and the accessibility of the population to safe food at accessible price. Milk and dairy products are important from a nutritional point of view, being indispensable sources of high quality proteins and bioactives with demonstrated functional properties. Nevertheless, being perishable, before reaching the end consumers, milk goes through production, processing and circulation, each step involving potential bacterial contamination that can affect milk quality and

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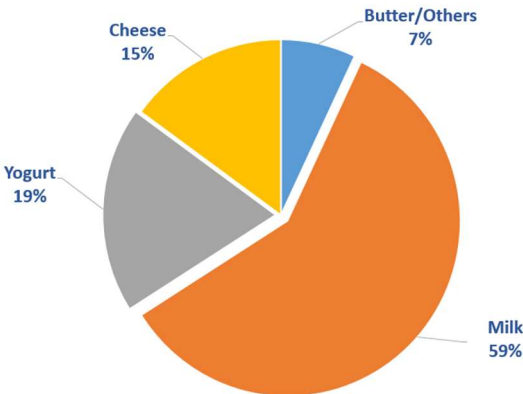
<sup>1</sup> Partnership on Research and Innovation in the Mediterranean Area (PRIMA) partly funded by EU's research and innovation program Horizon 2020.

safety. Another critical hazard related to food safety of milk is the use of antibiotics, which are widely used in veterinary medicine for dry cow therapy and mastitis treatment in lactating cows, causing the presence of antimicrobial residues in milk<sup>2</sup>. Besides being the most devastating disease affecting adult dairy cattle, mastitis is considered to be the most frequent and most costly production disease in dairy herds and the single biggest cause of antimicrobial use in the dairy industry<sup>3</sup>.

**2. Social and scientific context**

**2.1. Local dairy chain in Tunisia**

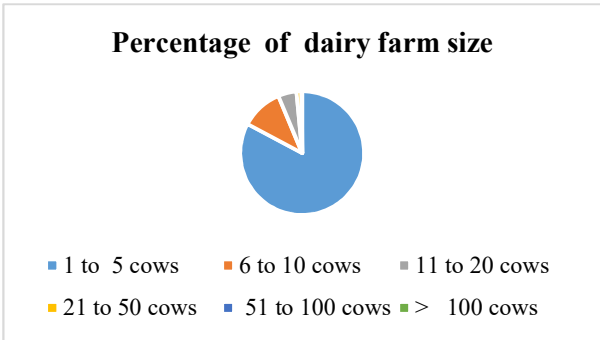
Tunisia’s dairy industry plays an important economic and nutritional role in the lives of many people ranging from farmers to milk hawkers, processors, and consumers. The dairy sector contribute with 11% of the value of agricultural production, 25% of the value of animal production , 7% of the value of the Agro-food industry and 40% of the value of working in the agriculture sector. Tunisia dairy policy change of 1994, incorporated small-scale milk producers and traders into the milk value chain and liberalized informal milk markets which has led to an increase in the amount of marketed milk, number of licensed milk vendors and a boost in demand for milk, leading to benefits for Tunisian milk producers, vendors and consumers. Milk consumption raised by 32% from 1994 to 2017 (117 liters/person in 2017). This is largely driven by increases in population, urbanization and incomes. Milk remains the principal dairy product consumed in Tunisia, with a noticeable and progressive increase of the consumption of other dairy products (Figure 1).



**Figure 1:** Distribution and consumption of milk and dairy products in Tunisia

Today, some of the main constraints to increased milk production in Tunisia have been attributed to poor milk quality due to refrigeration and farmer hygienic management. Collect centers are occasionally forced to throw a portion of their milk production because the presence of cells and antibiotic residues. Until 2015, it was estimated that only 70% of the national milk production was collected for exploitation<sup>4</sup>, with a waste of 412 million liters of milk with a major economic impact on crude milk price and market.

The dairy cattle population in Tunisia is estimated to about 850 million liters of milk based on 112 000 breeders and 424 000 female units of which 228 000 pure-breed female units. The dairy sector relies predominantly on small-scale farmers<sup>5</sup>, who own one to five dairy animals (Figure 2), producing about 80 percent of the milk in the country.



**Figure 2:** Tunisian dairy farm size repartition

<sup>2</sup> Mbareck and Sadack, 2015. Journal of Fundamental and Applied Sciences 7(3), 350-363.

<sup>3</sup> Bradley, 2002. Veterinary Journal 164: 116-128.

<sup>4</sup> GIV Lait (Groupeement Interprofessionnel des Viandes et du Lait) (2017) Secteur de l’élevage en Tunisie: la filière lait, Tunis, <http://www.givlait.com.tn>

<sup>5</sup> Gargouri et al., 2014. Animal Science Journal 85: 714-721

Milk collection and processing is another specific concern in Tunisia that has changed significantly since 1960. According to the industry statistics (Tunisian Dairy Board) , there are an estimate of 45 dairy industrial units with a processing of about 5.5 million liters/day as well as a network of artisanal transformers from all over the country with a large and diversified distribution network such as GMS-Wholesalers, Creameries and groceries. Regarding the collection network, there are 235 centers with collection capacity exceeding 2.6 million liters/day.

## ***2.2. Mastitis and antibiotic resistance issues***

Mastitis ranks among the most common diseases in dairy ruminants and represents a relevant economic issue due to production losses, culling and treatment cost. In addition, mastitis is responsible for 69% of the antibiotic treatments used by dairy farmers and constitute the first post of consumption of antibiotics in breeding<sup>6</sup>. The control of mastitis in dairy herds is an essential issue for society and the whole dairy industry. The conventional therapy against mastitis includes the use of antibiotics. The extended use of antibiotics is at the basis of the development of anti- microbial resistance that can persist in the bacterial community<sup>7</sup>, Furthermore, the massive use of antibiotics in dairy animals is at the origin of antibiotic residues' pollution in the environment and contamination of milk and other animal-derived products. In this context, breeders are increasingly looking for new solutions that would enable them to improve the control of mastitis while reducing the use of antibiotics.

## ***2.3. Potential alternative for Mastitis treatment: the approaches designed by MILKQUA***

Medicinal plants, herbal extracts and essential oils (EOs) are considered as promising agents. EOs are reported to be particularly efficient as antimicrobials. Eos are also known to extend the length of shelf life of dairy products<sup>8</sup>. Several strategies will be deployed by MILKQUA to test the effectiveness of the selected bioactive molecules as preventive alternate and/or as a curative remedy against mastitis. Such treatments might modulate the ruminal microbiota, thus increasing the degradability and digestibility of fibers to produce volatile fatty acids and synthesize microbial protein as an energy and protein supply for the ruminant, respectively<sup>9</sup>. It has been suggested in the literature that feeding animals with medicinal plants might also be a very promising strategy to reduce the burden of mastitis. According to DOHaD concept (developmental origins of health and disease), early life is a sensitive window where nutritional factors in humans may affect developmental plasticity of the organism, with consequences along the whole life<sup>10</sup>. Early nutritional events with the inclusion of EOs in the milk replacer of dairy calves will be tested by MILKQUA as a strategy to “program” health, milk yield and feed efficiency. In our opinion, attempting this novel approach would be worthy thus representing a noticeable advance beyond the state of the art. A reduction of the total cost of the treatment is expected with to either increase feed efficiency and/ or prevent mastitis in dairy cows.

## ***3. The idea behind MILKQUA project***

MILKQUA aims is to enhance global food security and dairy food quality by reducing antimicrobial use on Tunisian farms in the context of a ONE HEALTH perspective. The solution proposed by MILKQUA is to plan, scope, implement, and monitor milk quality along the entire dairy chain from udder to consumer. Quality Management involves food safety issues by awarding consumer about antimicrobial use and antimicrobial resistance and forming stakeholders to achieve a qualitative goal within an effective cost and time frame, decreasing the use, and misuse of antibiotics by testing the potential of phyto-derived compounds and essential oils as natural anti-microbial or immunomodulatory compounds. In order to develop a safe and sustainable dairy chain and reduce as much as possible the

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<sup>6</sup> Bradley, 2002. Veterinary Journal 164: 116-128.

<sup>7</sup> Andersson et al., 2011. FEMS Microbiology Reviews 35 (5): 901–11.

<sup>9</sup> Castro-Montoya et al., 2015. Livestock Science 180: 134-142.

<sup>10</sup> Mathias et al., 2014. Eur J of Nutrition 53(3):711-722 .

use of antibiotic and the consequent increase of antibiotic resistance in cows and humans, MILKQUA proposes a three -fold approach:

To implement a quality milk program to improve udder health by those involved in managing dairy herds and the milking process. Success of implementation such program depends on the willingness of farmers to change their behavior. MILKQUA will allow practices farming improvement on anti-microbial use through the use of Information and Communication Technology (ICT). A permanent information exchange between the farmers and the actors of the supply chain using participatory educational, training and accessible ICT to contribute to a permanent increase of the dairy value chain will be designed to fullfil such objective

To reduce the use of antibiotics by optimizing the use of local natural bio-compounds, that will improve the immune system of the animals, acting in synergy with antimicrobials, reducing the incidence of mastitis, and eventually decreasing the antibiotic-resistance for cattle and humans.

To monitor the safety and quality of milk and dairy products throughout the dairy chain, from udder to consumer, relying on data collected from MILKQUA evidence-based approach including OMICS technologies and *in vitro/in vivo* studies. System biology approach to improve our understanding of the immediate microbial response to antibiotic exposure would allow discovering new routes to fight the early onset of antibacterial resistance development, as well as to monitor the potential of natural antibiotic molecules.

### 3.1. The Structure and the multidisciplinary approach of MILKA

To address the scientific issues outlined in the Research Program and to achieve the objectives of the project, the Consortium has arranged project applied research blocks (WP2-7), each of them focused on one specific aspect of innovative feeding addressed in MILKQUA. A training and a dissemination block (WP8 together with the management WP1) complete the implementation plan. Figure 3 illustrates the relationship and the interactive character between the WPs.

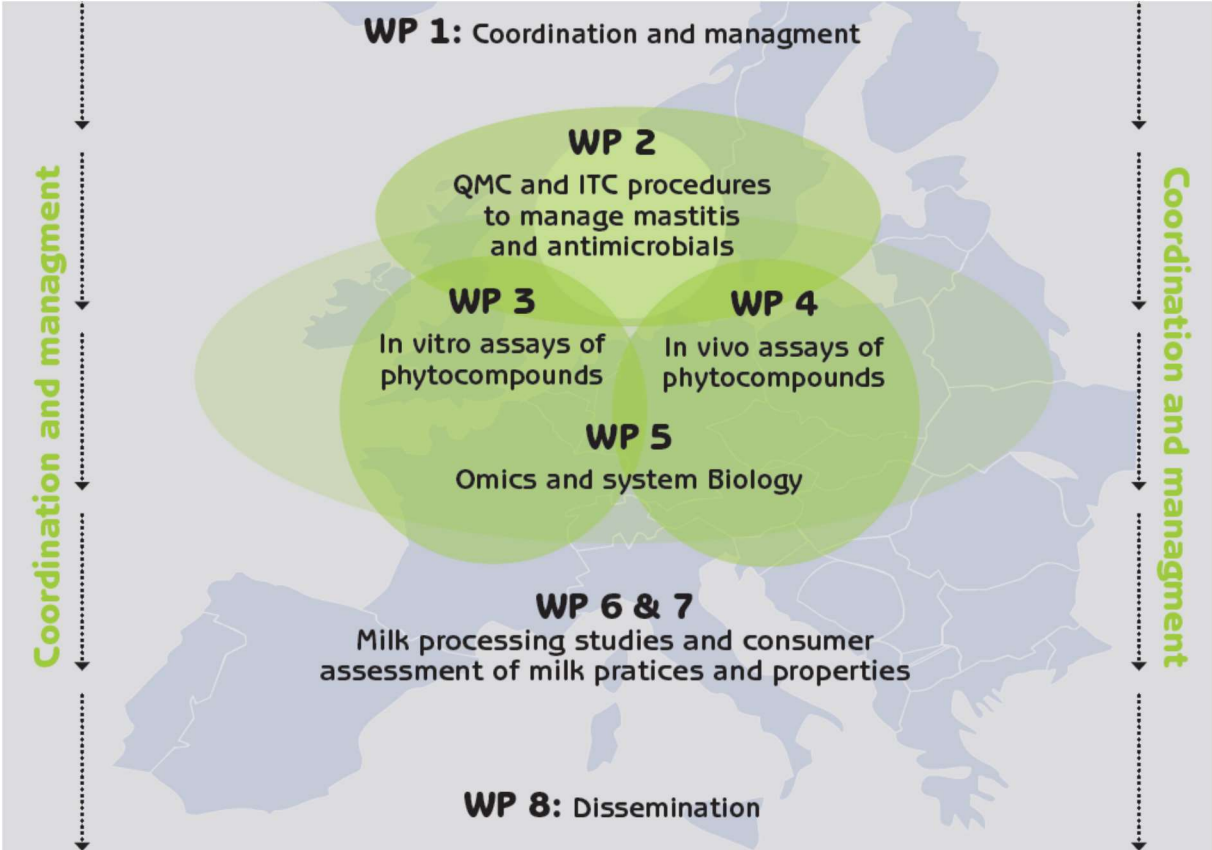


Figure 3: MILKQUA pert

### ***3.2. Ambition of the MILKQUA project***

Tunisian dairy sector is still facing difficulties in fodder management for the production of good quality milk. Moreover, around 30% of milk is discarded by dairy collection centers due to poor hygienic milk and the presence of antibiotics residues. MILKQUA project has the ambition to implement a national program that will help to improve the quality of milk produced in Tunisia by learning how best to reduce mastitis without over-reliance on antimicrobial use. A local plant based innovative research project will be developed thanks to the international expertise of different laboratories and tested at the scale of experimental farms and small industrial units. The project has the ambition to develop novel bioactive molecules in the dairy sector and veterinary medicine and apply new technologies, such as application of OMICS technologies to food quality analysis. The gender dimension is included in a specific task since it is intended to develop training courses for women on food security as well as on how to select plant with nutraceutical properties for small dairy farms in rural areas. The overall results are expected to be a potential model to be implemented at medium and large term in other Mediterranean and southern countries.