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Small dairies design to improve safety and workers' welfare in mountain areas

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Abstract

According to the laws in force the main requirements concerning food factories deal with their hygienic condition, safety and welfare for the workers, environmental protection from contaminants and processing functionality.

This paper points out the interaction between building solutions - such as their design, layout and materials - and environmental quality and aims to find crucial points related to hygiene and safety under working conditions. In particular, it analyses the interior materials mostly used for food processing, together with ripening premises. It examines the capacity of the materials to stand chemical and physical corrosion/aggression as well as the cleanliness of the premises, that is their suitability and compliance with legislation regarding safety in a working environment.

Through the analysis of several dairies, the major problems concerning hygiene were found to be connected with their incorrect layout, which is unsuitable for food processing, with the materials used, as well as with their design fostering filth. In fact, missing sealants between tile joints promote microbial development by accumulation of organic stuff similarly to what happens inside insufficiently ventilated premises. Moreover, old dairies show not washable walls, scraped plaster especially in poorly ventilated areas behind the vat and concrete floors highly deteriorated by lactic acid deriving from prolonged spilling of acid whey.

All problems are mostly due to inadequate knowledge by designers of the details concerning food processing, the necessary equipment and the conditions required by the process itself. Eventually, several buildings did not result to be safe, functional and convertible as they were not specifically designed for food processing.

Keywords: building structure, layout, finishing materials, environmental condition.

Introduction

Processing food means primarily protecting consumers by manufacturing safe food. Food safety requires integrated strategies for the whole supply chain including: sense of responsibility from workers, conditions steadily fit for conservation and eligible quality related to the environment and the structures of the buildings where products are made.

Several reasons can affect both structural and environmental conditions of food processing businesses:

- frequently they are housed in buildings not specifically designed for that purpose, so they lack safety, functionality and convertibility;
- being small businesses, their financial resources may not be enough to conform their buildings with regulations; in case they do, contradictory results can derive from the resources being low;
- improvements are usually due to sanctions to be avoided rather than to the businesses themselves to be ranked;

- they are designed without proper knowledge of the details concerning food processing, the necessary equipment and the conditions required by the process itself.

On account of what stated above and of the information gathered, this paper aims to make suggestions for a proper and functional design concerning small dairy facilities.

Material and methods

A survey was carried out in small dairies situated in mountain areas, usually close to their breeding farm; they process milk using craft methods to make cheese from local tradition. The businesses are situated in the valley floor (9 dairies) or on mountain pasture (9 huts) located in Valsesia, Valcamonica, Altopiano di Asiago and Monte Grappa

Our aim consisted in the examination of building and environmental quality of the dairies as well as their functionality related to both their specific production and business management. First, we checked for the basic building requirements consistent with EC regulation n. 853, 2004.04.29 (attachment II), even in the consideration of structural exceptions allowed to traditional productions.

Therefore information were gathered about the building structure, such as its layout, building typology, peculiarities of its architectural parts, finish materials, state of repair and cleanliness of the premises; about production, that is dairy processing, its flowchart, environmental conditions deriving from processing and required by the different production phases, its technology, its productive capacity and so on; about the management of the productive activities, e.g. method, timing and labour employed for cattle breeding and treatment, milking, cheese-making and dairy product selling.

Specifically, the following aspects were considered while examining the building structure:

1. protection of its interior from outside contamination or aerial contamination spread inside areas with different hygienic standards, through measuring air microbial charge;
2. cleanliness and preservation of the premises in respect to their specific processing, such as skimming, cheese-making and ripening.

As to aspect 1, protection from contamination of areas devoted to processing and reduction of transmission of aerial contamination, were examined the following aspects:

- level of care and state of repair of areas external to the dairy;
- existence of flooring between cattle-shed /dairy and around the buildings;
- layout, i.e. location and distance of the cattle-shed from the dairy, entrance to the buildings, arrangement of the processing premises, plants and equipment in relation to cheese-making flowchart;
- existence and integrity of systems due to stop infestation from outside, e.g. anti-insect nets, protective grids for openings, vents, drainage and so on;
- existence of structural parts favouring dust accumulation and dispersion.

Regarding aspect 2, were checked carefully adequate hygienic conditions and maintenance:

- internal finishes which should be easily cleaned, by measuring microbial contamination on their surface, and considering both how frequently and how they were cleaned;
- resilience and state of repair of such finishes considering their level of damage/deterioration;
- any hollow, crack, gap or any surface difficult to be reached;
- the dimension of the processing premises;
- possible presence of condensation or undesirable mould.

Results

External environment

In the mountains the external environment does not imply dangerous contaminating sources, as polluting industrial settlements are rare, and dairies are usually located within small urban contexts, such as the foot of a valley, or within isolated areas, such as alpine grazing.

No critical situations for hygiene due to external environment were found, except for one case because of a neglected massive vegetation as a possible source of weeds and waste leaning against the building.

Dairies within urban contexts showed external asphalt or concrete flooring and frequently an adequate slope to rainwater drainage. In some cases, soil subsidence was noted, which could provoke rainwater stagnation. In other cases, flooring only consisted of a layer of gravel, which anyway could avoid dust rising.

In an alpine environment, dairies are surrounded by pastureland. Where any flooring, was given, this might only consist of an area in front of the entrance to the dairy or of a one-or-two metre large concrete track around the building. To reduce contamination transmitted through air, the location of the cattle-shed as to the dairy, as well as its internal layout were considered very important.

Location of the premises

In the examined cases, the location of the cattle-shed as to the dairy showed the following typologies (Fig. 1):

- A: dairy and cattle-shed are sited in a single building;
- B: dairy and cattle-shed are sited in two different buildings with adjacent entrances;
- C: dairy and cattle-shed are sited within a distance of more than 50 metres.

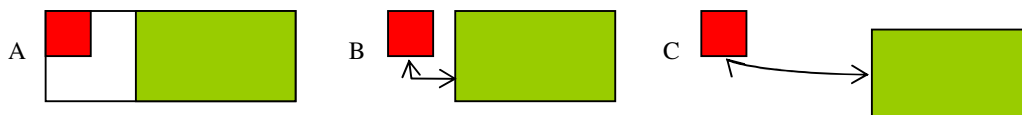


Figure 1. Location of cattle-shed (green) as to dairy (red)

The building typology of case A, when managed correctly, allows to keep distinct hygienic conditions of the two spaces. Air microbial charge measures showed it is possible to keep a difference of 10^3 - 10^4 magnitude in the microbial concentration between the cattle-shed and the dairy by simply closing the entry doors.

In case B contamination risk between cattle-shed and dairy is more frequent if doors and windows of both buildings overlook the same area and are kept open.

As to C, no microbial contamination through air is given when the cattle-shed is far enough from the dairy. Environmental contamination is present if between the cattle-shed and the dairy there is no flooring, not even consisting just of gravel or stones. In fact, the milker can dirty the premises of the dairy coming from the cattle-shed in muddy shoes. A water distributor external to the dairy can be useful.

Dairy Layout

According to the production process, dairies usually show from 2 to 4 premises. When the processing includes natural milk skimming, there is a room suitable for surfacing of fat globules; a necessary exclusive room to guarantee proper hygienic and environmental conditions of fresh temperature and ventilated ambience to the milk. In some dairies, natural milk skimming is performed in the same premises where milk is processed. In such a case, a correct organisation of the processing is due, so that no one is in the premise when milk settles.

Rooms for cheese-making and ripening are always given. A room for cheese dry salting can also be found. If cheese is brine salted, small tanks are normally set inside the ripening room. The ripening room must be fresh, ventilated and with no sudden change in temperature; that is why it is commonly a cellar under the ground. Ripening rooms in different building typology are also given; in such cases any possible contamination of cheese when carried outside must be avoided.

Internal layout of the premises might not allow the unidirectional progress of the processing flow, as it can occur in some dairies. Critical situations are due to an incidental use of processing premises. Dairies in the valley floor show more articulated layouts (U or L) consisting of premises specific to milk delivery and check; to churning; equipment cleaning; laboratory; staff changing room and facilities. Where performed, it is recommended to isolate equipment used for mechanic skimming and pasteurization inside a specific soundproof room to reduce staff's exposure to noise.

Protection from contamination sources of the internal environment

Systems against pest, such as grids for drainage or openings, were often not found. By passing through different rooms, pipes somehow created a connection among them; not every window installed anti-insect nets and the ones given were under a very bad hygienic and repair condition. A great deal of dust showed to be accumulated on beams, on internal windowsill and other flat surfaces, on hanging lamps and electric wires. To avoid filth, they should be as few as possible or at least inclined at an angle of 45°-60°, or again be covered with a round rake.

Adequate hygienic conditions and repairs in the processing premises

Good hygienic conditions, but moderate repairs for the processing premises checked. Damaged finishes, often decayed or even non existing on some surface areas. Different conditions depending on different resistance to mechanical and chemical stress of the materials used as internal finishes. The dimension of the space devoted to working operations seemed proper, even if cleaning the environment, the plants, and the equipment would be easier if they were placed at least one metre far from the walls.

Flooring

Red or glazed stoneware were the common flooring of the premises devoted to skimming and cheese-making, for older buildings and more recent ones respectively (Fig. 2/A). Washable, waterproof, chemical resistant, but with low resistance to mechanical stress if their thickness is not adequate. Moreover, red stoneware with a smooth surface is highly slippery especially in the presence of water and fat.

Concrete would not be suitable in such premises being scarcely hygienic and highly slippery, showing low resistance to acidity due to whey and lactic acid and dust when ageing. It is commonly used in the ripening rooms.

Flooring in synthetic resins are smooth and regular and having no tile joints they produce low noise even in the presence of trolleys carrying and moving the products. Ucrete would be the best synthetic resin for dairies among the products on the market, but it is not much used; it was found only in one dairy in the valley floor.

Glazed stoneware or red stoneware and concrete were usually found in the ripening rooms. Older buildings showed slabs of stone or gravel; wood boards on a concrete basis able to increase thermal conditions of the room was the flooring found in a hut. Ceramic materials were mainly noted, but they require the use of tiles well resistant to static and dynamic stress. A resistance due to proper thickness, dimension and geometrical shape of the tile itself. Clinker would be the best ceramic stuff for dairies, being hygienic, durable, chemically high resistant, almost waterproof, and 18-20 mm thick to offer adequate mechanical resistance. Only used in the largest dairies because of its cost. While fitting a floor, anti-acid products as sealants for tile joints should be used to avoid the bed deterioration, which anyway is not generally much considered. For the safety of the workers, flooring should be anti-slippery especially when washed; so tiles should undergo the following values:

- Friction coefficient $R=13$ (DIN 51130);
- Compression space $V=6-10$ (DIN 51130);
- Slippery resistance $\mu>0,50$ (B.C.R.A.).

Vertical finishes

The skimming and cheese-making premises generally resulted tiled or PVC wall-boarded. (Fig. 2/B). It is recommended to fit tiles for these walls having a determined thickness to make them resistant to strokes and knocks and to use metallic staff angles and boards to protect both angles and transit areas. Hygienically unacceptable are some mixed solutions where walls are tiled up to two metres and no finish is given above.

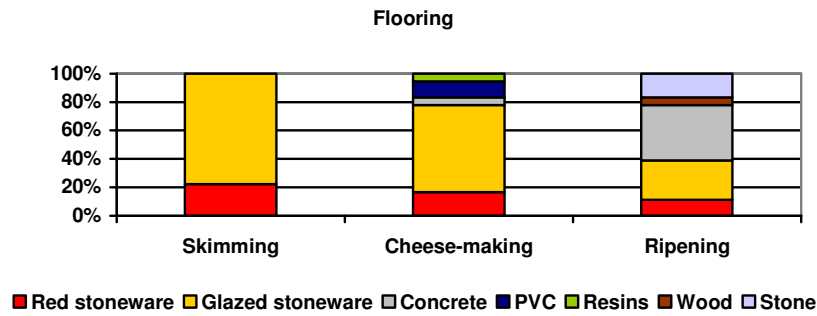
Paintings must be waterproof but breathable, to stand repeated washing and to avoid the peeling off of the finish. Paintings have no joints, but are less durable and need periodical renovation. Their resistance to environmental conditions must be carefully considered; in fact, they can rapidly decay in areas scarcely ventilated, such as behind a vat. High washable water-painting resistant to severe environmental conditions, such as high humidity and low ventilation, are nowadays marketed; inhibitors of micro-organisms, moulds and algae are also added. These paintings can be used on several finishes, even if its good and long durability can not be guaranteed on existing finishes. PVC wall boards are easily washable and show good resistance to mechanical and chemical stress; moreover they can be used to create defined spaces inside wide areas.

The ripening premises evidenced many and varied finishes, mainly raw concrete walls, but also plastered, tiled or PVC boarded. Environments with walls made in concrete are more subject to temperature range than where walls are made in bricks or stones.

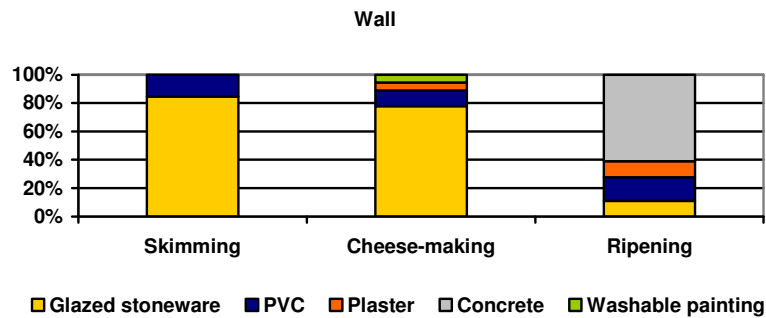
It is necessary to accurately prepare the bed with an intermediate layer of polyvinyl materials or epoxies to seal joints, cracks and hollows before plastering and laying the finish just to avoid filth accumulation and pests.

Ceilings

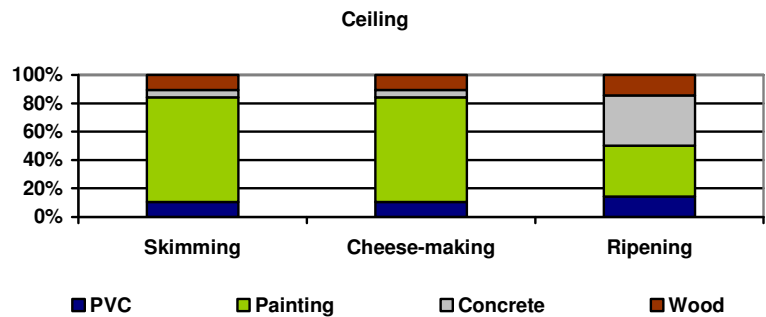
Ceilings (Fig. 2/C) were simply painted or made in PVC boards; in the ripening rooms they were in raw concrete. Huts showed wooden ceilings and also wooden building covering, a solution requiring more care and repairs. In fact, much mould was found in ceilings placed in low ventilated environment, which calls for periodical renovation of the painting.



A



B



C

Figure 2. Finishing materials used in dairies

Doors and windows

Doors and windows were wooden or made in metal. Insulated PVC doors were used for the air-conditioned ripening storerooms.

Wooden doors and windows need frequent cleaning and good repairs being porous and moisture sensitive. The bacterial charge measured on their surfaces demonstrated that when regularly brushed figures concerning wood are low, only few CFU/cm² similarly to tiles. Window glass is responsible of high condensation, particularly in winter. Therefore it is important to install glass apt to better thermal performance of the windows; e.g., low emission glass covered with metallic oxide can decrease heat loss and neutralize condensation, or high thickness glass, double-glazing and layered glass covered with viscoelastic material can also

be sound-proofing. Self-cleaning glass can be adopted where the windows are not easily accessible. Self-cleaning is due to a photo-catalytic and hydrophilic material which UV beams activate to decompose organic filth and make the surface hydrophilic. Rain water then washes decomposed residues and mineral dust. Sunlight in the processing premises can be reduced by installing windows including shutters in their double-glazing.

Doors and windows must be made in round, full or foamed structural shape. Windows in line with the wall are a good solution to avoid details which can be used as hygienically critical bases.

Conclusions

Traditional cheese productions are evolving as to their peculiarities because on account of different reasons their production environment is changing. Better hygiene of the processing premises requires the use of washable finishes, often incompatible with traditional stones and wood.

Processing premises in alpine grazing consist of small buildings, not always showing a good standard of repairs that could guarantee optimal hygienic conditions for cheese-making. No doubt such premises must become consistent with the European regulations about hygiene and environment. Nonetheless, the usual balance between a habitat and its bacterial population must be preserved while increasing hygienic conditions.

Traditional materials should not be associated to an idea of a filthy context; in fact, they allow a perfect harmony between the natural alpine environment and its buildings which represent its strong peculiarity.

In the last years, substantial financial resources have been invested on the repairs and restoration of existing buildings as well as on new ones. Frequently, contradictory situations occurred during such restoration work. In fact, processing premises originally made in stones were covered with washable finishes, but in many cases poor availability of water was not taken into consideration. Tiles for the finishes revealed scarcely resistant to stress due to the presence and transport of equipment for cheese-making, which is taken to the hut only during grazing period. In some cases, repairs and restoration resulted absolutely formal.

Actually, washable finishes can not be the only element favouring adequate hygienic conditions. Contamination must be reduced by adopting a suitable hygienic procedure during cheese-making, for example washing hands, or other works in the cattle-shed; by avoiding that other tame animals or people be inside during production and that waste be stockpiled nearby the dairy. And even distribution has a strong impact on the hygienic aspect of production.

A suitable management of production would be enough to produce food absolutely safe for the consumers even inside traditional buildings, especially in the consideration that exceptions to this scope have already been given. Buildings must be adjusted respecting traditional products. Regulations about hygiene when interpreted, notwithstanding exceptions, can represent a risk for the premises built in traditional materials, even to become illegal. And not only have traditional materials a strong appeal for the tourists, but also they have represented the best environmental conditions to make particular cheese for a long time.

It is therefore important to underline these aspects in the aim to supply exact information, even supported by targeted experimentation, concerning how to handle necessary adjustments in accordance with regulations just having in mind the safeguard and promotion of both typical products and traditional buildings.

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