A step-by-step comparison of Gouda cheese in artisanal and industrial production considering the organic guidelines during the production process

A ProOrg project about the processing of cheese

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Background

The refinement of milk into cheese is carried out under controlled conditions. Different production methods lead to a wide range of cheese products. The German regulations on cheese describe six groups of cheese which are produced according to a certain production process. The complex processes are assisted by biochemical reactions and vary according to the different production systems.
The following research questions of this work are examined with the aim to elaborate and visualise the technological procedures:

Which differences and commonalities can be identified by comparing artisanal and industrial cheese production of Gouda?

Which special requirements are set by the EU Regulation on organic production and organic food and farming associations and how do they influence the production process?

ProOrg

The research project ProOrg develops a set of strategies and tools (Code of Practice) to help organic food processors in the selection of appropriate technologies and innovations to support their processing methods. In line with organic principles it will give guidance for making the best choice for minimal and mild processing methods [1:2].

Materials & Methods

The research subject is narrowed to the cheese type Gouda, to clearly illustrate the complex process of cheese production. Based on a comprehensive literature review the research question were followed. The findings were put into relation and mapped in a flow chart.

The cheese production

The raw material milk. The chemical composition of milk is relevant for the production process and the later quality of the cheese [2:120]. The proportion of the components, lipids, protein, lactose, water and dry substances are influenced inter alia by feeding, the stage of lactation and the breed of the dairy cow [2:125; 3:326]. The usability of milk for dairy products is characterised by being inhibitor-free and a good renneting ability [4:258]. By producing semi-hard cheese made of milk, particularly from silage feeding, the clostridia spores can cause problems during maturation. Therefore, suitable technological procedures and additives are needed [2:18].
The cheese production. Technological processes are supported by biochemical reactions. Besides suitable technical facilities, further substances are needed: lactic acid bacteria and rennet enzyme are added while curd making, processing aids are used during maturation.
Gouda. The typical Dutch semi-hard cheese has a solid consistency with few holes. The cheese rind is normally coated with plastic [7:464].

Conclusion

The production of hard cheese is complex and varies depending on the type of cheese. Different parameters have impact on the technological procedure and the quality of the cheese. Divergences between artisanal and industrial products are identified in almost all process stages: The primary focus lies on the usage of technological aids and facilities as well as thermal, time, and acid parameters. The process quality and the quality of the raw milk as well as the additives influence the cheese quality. The usage of those materials is restricted by the EU Regulation on organic production and organic food and farming associations. Therefore, technological consequences during the processing need to be addressed. The illustrated technological differences can be partly applied to other cheeses. The organic requirements are valid for all types of cheese.

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industrial		artisanal
In automated processing lines, thermic and mechanic procedures are combined. Mainly the integrated short-term heating applies [3:98]. For the procedure of a standardised product the fat content will be adjusted, and additives used (e.g. Calcium chloride for coagulation [6:330] and colourings [3:334]).	**Milk Preparation**	Thermisation or pasteurisation by long-time heating is preferably conducted batchwise, mostly without standardisation measures. Partially also raw milk is used [8:18].
To generate large amounts of milk, the delivered milk is thermised and stored at under 7°C for up to three days in a silo [7:113].	To reduce the microbial content, thermal and mechanical processes can be applied. Natural fluctuations will be compensated and a standardised quality ensured. [3:328]. Thermisation or pasteurisation is used for heat treatment and if needed a mechanical removal of bacteria by a centrifugal separator [3:327]. For the Gouda production there is no obligatory procedure [5:929]. Usually pasteurisation is implemented [6:330].	Thermisation, not standardised: at least 15 sec. at 57-68°C Pasteurisation: long-term heating: 30-32 min. at 62-65°C short-term heating: 15-30 sec. at 72-75°C
		Unlike the organic food association guidelines, the EU Regulation on organic production does not exclude any specific standard procedures for milk preparation [12:113; 13:3; 15:4]. The use of milk preservatives is not allowed [9].
Application of starter cultures to ensure a standardised quality [2:130]	**Pre-maturing**	Application of starter cultures or the use of cultures from own reproduction [7:188].
aim pH 5,9	The milk is cooled to a suitable temperature for renneting and the pH-level is lowered via lactic acid cultures (starter cultures). For Gouda the mesophilic acidification culture *Leuconostoc mesenteroides subsp. cremoris* is used, which results the characteristic holes [11:490].	aim for pH < 6,6
Cold pre-maturing during cold storage, to shorten the time of pre-maturing to guarantee a standardised quality [10:263; 7:151]	Cultures are added at 29-32°C	The lactic acid cultures may not be genetically modified or reproduced on genetically modified substrate. All standard acidification cultures are allowed [9: para. 9, item. 1].
	Renneting	Rennet is added at 29-32°C
Pre-curdling process: the gel firmness is tested with instruments which determine time, pH-value, light- scattering and reflection [3:336; 7:265]. The cutting takes place in cheese vats with integrated cutting and stirring tools [10:281].	To generate a stable cheese, rennet is added. This enzyme causes the milk coagulation by developing stable calcium-casein complexes [10:272]. After adding the rennet, it is important that the milk comes to a standstill in order to avoid disturbing the coagulation process [3:336].	Animal rennet and rennet substitutes are permitted. Organic food & farming associations like *Naturland* and *demeter* allow Calcium chloride as additive for enhancing coagulation [12:31; 13:2].
	Coagulation time: 20-30 min.	
Curd washing: the whey drainage occurs through the integrated vat sieve with external suction connection. Large amounts of whey can be removed [3:337].	**Post-Coagulation Process**	Pre-curdling process: The firmness is manually determined with fingers or knives [7:265]. For cutting, specific handicraft tools like curd knives, scoops and cheese harps are used [10:279].
Knitting of curds: For further stirring and loss of whey, the whey-curd mixture is put in a buffer tank [3:358]. The adjustment of the right degree of acidity takes appx. 1 hour [7:489]. The buffer tank cools the whey-curd mixture in order to regulate the pH-value [3:341].	The gel will be cut and breaks the curd into grains (pre-curdling process). It leads to a release of whey out of the cut grains [3:336]. The cut grains are washed to reduce the lactose and to adjust the pH-level, the whey-curd mixture is heated up to 38-40°C. While the whey drains, the stirring needs to be stopped to avoid clumping. This step must be done quickly [8:86; 14:291]. The knitting of curds is followed by further stirring of the mixed curd grains and whey [3:358; 6:331].	Curd washing: The less technical process of whey drainage occurs via holes in the wall of the cheese vat [3:337].
	Curd washing: Removing 30-40% whey Adding 10-20% hot water	Knitting of curds: Further stirring takes place in the cheese vat for about 5-15 minutes [8:176].
	Knitting of curds till pH < 6,5	
Prepressing takes place in prepressing vats or draining systems, which are integrated into processing lines [3:343].	**Pre-Pressing**	The whey-curd mixture is put in pre-pressing vats. A pre-pressing can also take place in perforated sieves or plates inside the cheese vats [8:90,53].
	To generate a semi-hard cheese without air pockets, the cheese curd is pressed to release additional whey [3:339]	
	Pre-pressing: 10-15 min. at 0,04-0,08 bar	
The cheese blocks are cut with cutting tools [3:341]. For efficient use, the moulds are rectangular and made of plastic or stainless steel [3:344; 2:135].	**Portioning**	Kadova-moulds are primarily used: Comprising of a mould and a top. Inside the mould is a removable net to enlarge the surface of the cheese during pressing and to enhance the whey drainage [8:53].
	Suitable pieces are cut out of the pre-pressed cheese and put into the moulds [3:342].	
The pressing is integrated into the processing lines using tunnel or column presses [10:89].	**Pressing and Turning**	Mainly manually applied, vertical presses or trolley table presses are used [3:346] . Characteristic for Dutch cheese is the usage of lever presses [8:59].
	The cheese is pressed inside the mould and turned several times [8:177]. This promotes a further loss of whey and the developing of the rind [3:345]. Pressure should be increased stepwise [10:288].	
	Pressing: up to 4 hours at 2-5 bar	
The curd is salted in brine (saturated or surface brine) which is integrated into the processing line [3:349].	**Salting**	Dry salting or for larger batches salting in brine is applied [8:59].
	The raw cheese is treated with dry salt or salt brine, inter alia for dehydration and to form rind and flavour [11:28].	Sodium or potassium chloride salts can be applied. Contrary to *Naturland*, the association *demeter* excludes anti-caking agents in salt [12:33; 13:2]. The association *Bioland* does not have specific requirements.
	Brining 1 kg: ca. 20 hours, 9-10 kg: 3-5 days	
Maturation with surface treatment or foil bags. Mechanical application of the coating [7:413].	**Maturation**	Manual application of the coating [8:99].
	Microbiological and enzymatic activities lead to the formation of rind and flavour [10:297]. Each cheese type has its own demands on temperature and humidity [3:353]. For surface treatment a plastic dispersion is used: The coating is applied from outside as physical barrier against mould [6:331]. Maturation in a foil bag is possible [3:354].	Processing aids can be used for surface treatment. Only at *Naturland* are processing aids for ripening forbidden [13:2]. *Bioland* and *demeter* have specific requirements: plastic dispersion for coating may be applied [15:5; 12:113].
	10 days at 10-12°C in total 2-12 months at 12-15°C	