

# Quality determinants in the organic cheese supply chain: a Quality Function Deployment approach

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## Introduction

In this study, we present some of the results of the E.QU.I.ZOO.BIO (*Efficienza, Qualità e Innovazione nella Zootecnia Biologica*) programme that is funded by Regione Marche and is related to food quality development in animal production.

Little is known about the relationships between consumer requirements relating to food product quality and supply chain processing requirements (Benner et al. 2003).

The aim of this study is to facilitate the food product development process by integrating the needs of the consumer into the animal processing characteristics of organic 'pecorino' (sheep milk) cheese. At the same time, we test the Quality Function Deployment (QFD) method to determine its usefulness for the development of a food product and for the differentiation of quality levels (Benner et al., 2003). A deep analysis of the existing literature that deals with the use of QFD for food product development reveals that the methodology is still applied to few food products (Costa et al., 2001). Although QFD has been used in the food industry since 1987, foods are complex products, and consumer/producer requirements/interactions are variable and appear never to be the same. To our knowledge, there have been no other such studies on organic food or on cheese.

A holistic approach to evaluate and measure food quality is proposed, together with suggestions for future research.

## Abstract

*This report presents the results from an Italian study on the improvement of cheese quality in the organic sector. The Quality Function Deployment technique has been applied. The data show that among the visual characteristics of 'pecorino' (sheep milk) cheese, consumers assign the greatest importance to animal welfare, origin, and production process. Price and product appearance (colour and presence of holes in cheese) are of secondary importance. To meet these needs, producers can effectively operate along the supply chain by acting on: sheep feed composition, housing, genotype lines and stocking density (number of sheep per m<sup>2</sup>). Animal welfare, which is shown to be the most important aspect for the consumer, can be enhanced by means of the housing and stocking density. The less important issues, although not of secondary importance in terms of food safety, are those that affect cheese maturing, production technology, and dairy milk treatment.*

**Keywords:** House of Quality, Quality Function Deployment, organic cheese, quality determinants.

## Materials and methods

The QFD approach is effective for determining how to prioritise customer needs in order to answer to them effectively. Products must be developed to meet the demands and preferences of the consumer (Akao, 1990). QFD is applied to define the needs of the consumer, and to translate these into specific actions that result in the production of products that

meet these preferences (Vatthanakul et al., 2010). Through the participation of the members along the supply chain, the QFD method supports decisions relating to which of the relevant consumers needs should be focussed on, to assure quality improvement and to fulfil customer satisfaction. By focusing on the interactions between the different phases of the production process and the needs of the consumer, the QFD method is effective for the improvement of food production. The quality of a product is not only a matter of the ingredients involved, as it also relies on the processing characteristics and depends on the actors involved in the production process (Brunso et al., 2005). One of the strengths of the QFD method is that it encourages communication along the supply chain and between the chain members (Benner et al., 2003). By exploring the wishes of the consumer, this process helps to exploit the dynamic and heterogeneous needs of the consumer.

We apply the QFD method for the development of pecorino cheese quality, from a supply chain perspective. The construction process started with the 'House of Quality' (HoQ; so-named due to its house-like shape) or 'Product Planning Matrix'. This is the first of four different matrices that are usually built into a QFD study (Benner et al., 2003). The HoQ was built relating the needs of the consumer to the appropriate product and processing characteristics of pecorino cheese.

The consumer needs (the 'whats'), the ranking of the consumer needs, the processing characteristics requirements

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(the 'hows'), and the relationship matrix were determined to obtain importance ratings for each how (the 'how much') (Benner et al., 2003). Previous literature and expert opinion were the essentials for the creation of the HoQ.

In the present study, the QFD approach is applied to the visual measurable attributes of the product investigated as perceived by the consumer, which were determined by asking the consumer when the cheese was selected at the point of purchase. The consumer needs – also known as the 'voice of consumer' – were determined using our own expertise of consumer research.

Table 1 - Consumer needs for pecorino cheese and the definitions of the choices (the 'whats').

Product characteristic	Definition	Choices			
Colour	The colour of the pecorino cheese as sold on the supermarket shelves	Yellow	White		
Holes in the cheese	Holes in the cheese	Present	Absent		
Farming system	The farming techniques adopted to raise the sheep	Organic	Conventional		
Animal welfare	Chance for the sheep to have access to the outside environment	Outdoor access	No outdoor access		
Product origin	Country of origin of the milk used to make the cheese	Italy	Outside Italy, EU		
Price	Selling price in Euro/kg	8	16	24	32

After pretesting, the data acquisition for the consumer needs ranking took place at the end of a choice experiment, the results of which have been published previously (Napolitano et al., 2010). Consumer data collection took place at three different locations (Udine, Potenza, Ancona). The sample size was 149 consumers. These buyers of pecorino cheese were selected from among consumers who stated that they were knowledgeable about organic issues. A preference-data questionnaire was submitted after this experiment, to collect the stated choices of the consumer (elicitation of attribute attendance) (Zanoli et al., 2012).

Table 2 - Product requirements and definition of the pecorino cheese supply chain (the 'hows').

Technical characteristic	Definition
<b>1<sup>st</sup> phase: Production</b>	
Genotype lines	The sheep are selected for high milk yield.
Animal-feed composition	Animal feed with high concentrations of nutritional value (i.e. low level of fibre, high level of protein as used in an intensive system). Organic rules impose a minimum amount of fibre in animal feed.
Genetically modified ingredients	Genetically modified ingredients in the animal feed. Organic rules allow at maximum 0.9% genetically modified ingredients in animal feed.
Free-range housing	Sheep have access to the outside (paddock)
Stocking density	More than 0.7 sheep per square metre in the sheepfold.
Bad handling	Bad handling conditions before and during milking process. Little expertise and/or bad handling behaviour and/or lack of handling equipment.
<b>2<sup>nd</sup> phase: Processing</b>	
Treatment of milk	Pecorino cheese produced from thermalised sheep milk.
Dairy technology	Pecorino cheese made using selected autochthonous starter.
Maturing process	Pecorino cheese matured for more than 5 months.

The consumers were asked to self-declare how much they felt they paid attention to each attribute during their choice experiment. They had to rate these on a 9-point Likert scale (9: always; 1: never), as the frequency of selection of each quality cue: colour, presence of holes, sheep farming system, animal welfare, product origin and price (see Table 1). The average value of each attribute is reported in the weight/importance column of the HoQ (Fig. 1, left side) (Vatthanakul et al., 2009).

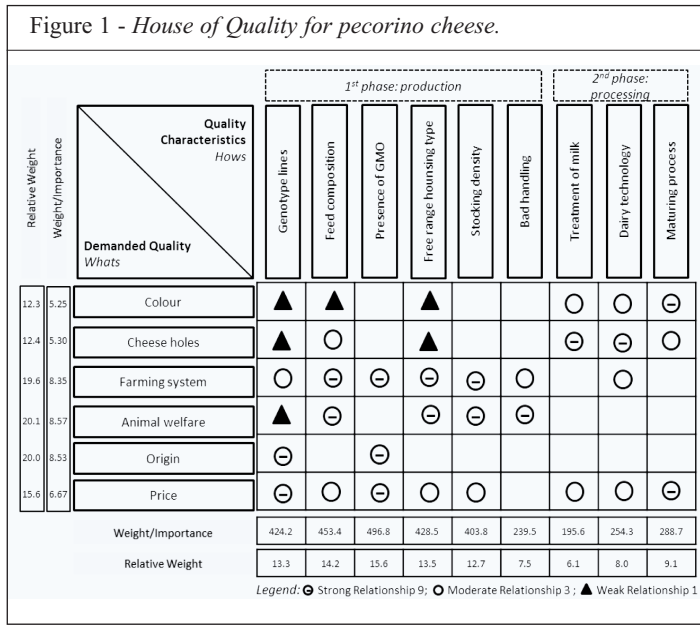
The requirements of the processing characteristics – also known as the 'voice of the producer' – and the relevant relationships (the 'relationship matrix') between both the intrinsic and extrinsic characteristics of the product quality (consumer needs) and the production process requirements were obtained through expert opinions. Tables 1 and 2 give the lists of the consumer needs and the definitions of each product quality cue and processing requirement, as agreed by the expert panel. The strength of the relationships between the consumer needs and the processing requirements were established in autumn 2009, during a focus group meeting of an interfunctional expert team (Hauser and Clausing, 1988). Seven experts were recruited as the expert panel, from among producers, technicians, and researchers. The participants were asked to

consider and discuss the relationships between the consumer needs and the processing requirements, and then to rank these relationships into three levels (scoring: 9, strong; 3, medium; 1, weak). In the interrelationships matrix (Fig. 1), these relationships are expressed through symbols. (e.g. the relationship between 'animal welfare' and 'animal housing' is strong, the relationship between 'colour' and 'genotype lines' is weak). We did not determine the interactions between the determinants of the production process by expert assessment – the roof of the HoQ – as this was beyond the scope of the present study.

The product requirements (the 'hows') of the pecorino cheese supply chain that contributed to consumer expectations are classified into two main categories, or phases:

1. Production phase (sheep genotype lines, animal-feed composition, genetically modified ingredients, free-range housing, stocking density, bad handling conditions);
2. Processing phase (treatment of milk, dairy technology, maturing process).

The bottom of the HoQ (the 'how much') shows the technical importance rating (absolute and relative weight), and this helps to determine priorities and offers guidelines for possible improvements in the production process phases. The HoQ analysis of these pecorino cheese priorities shows the effects of the production process phases for the product quality required by the consumer. The relative weight (Fig. 1), bottom row is obtained by multi-



plying the relationship scores for each process characteristic by the consumer need scores, and normalising the final score (absolute weight)<sup>1</sup> (Vatthanakul et al., 2010).

## Results

The results are shown in the HoQ planning matrix (Fig. 1), where the most important quality attributes required by the consumer (Fig. 1, left side) are predominantly related to the characteristics of the production process. The most important quality cues that the consumer checks when selecting pecorino cheese from the shelves are: animal welfare (8.57), of Italian origin (8.53) and from an organic farming system (8.35). The visual characteristics of the cheese (cheese colour, holes in the cheese) and the price level are only occasionally noted. These consumer choices have a deep influence on the producer priorities. According to the results, the most relevant producer priorities, expressed either as the absolute or the relative weight (Fig. 1, bottom row), delineate the directions for potential improvements. The priorities with the highest relative weights are especially related to the milk production phase. ‘Genetically modified ingredients’ and ‘animal-feed composition’ are the most important processing characteristics, closely followed by ‘free-range housing’ and ‘sheep genotype line’. In the cheese-processing phase, characteristics like ‘maturing process’ and ‘dairy technology’ have key roles in the analysis of the determinants affecting consumer expectation. The least important aspect is ‘treatment of milk’.

## Discussion

The main findings show that consumer preferences are more affected by the milk production phase than the

cheese-processing phase. The analysis conducted in this study shows that attributes related to the feeding of the sheep, as ‘genetically modified ingredients’ and ‘animal-feed composition’, significantly affect the perceived quality of the cheese. In recent years, food scares related to the use of growth promoters and genetically modified organisms have increased consumer concern and awareness about the livestock production process and the product safety. These results confirm previous findings; e.g. Zanoli et al. (2012) showed that consumers appreciate organic animal products as genetically modified ingredients and synthetic chemicals are banned from organic foods.

Free-range housing conditions and stocking density also affect the perceived quality of the cheese. Milk producers often reduce their concerns about animal welfare, to cut the housing equipment and the labour costs. They raise sheep by increasing the number of sheep per square metre, and contextually avoid outdoor access for the sheep as a means to increase profitability. But Napolitano et al. (2010) verified that information about animal welfare issues, such as the type of animal housing and the stocking density, influences the willingness of the consumer to pay more for animal products. Specific mention should be made of the role of the processing requirements on the perceived cheese quality. According to these data, the processing requirements, such as the dairy technology and the maturing process, have the lowest relative weight. This represents low potential for improvement in terms of consumer needs and almost a total lack of relevant relationships between the main consumer needs (extrinsic cues) and the processing requirements. However, the importance of processing steps on consumer expectations should not be excluded. According to Guerrero et al. (2009) and Almlı et al. (2011), consumers are open to innovation of extrinsic cues only on the condition that they do not modify the fundamental intrinsic characteristics of the product; those that are mainly affected by the processing phase.

The QFD approach used for this analysis shows positive results and can be considered an important tool to help pecorino cheese companies to produce in a way that better meets consumer expectation. However, the results of our analysis need to be interpreted with caution, to avoid any inappropriate simplification. Further studies are needed, in particular relating to the analysis of the interdependency between the producer parameters (implementation of the correlation roof) and the elaboration of a more detailed design requirement (the whats). It is reasonable to assume that some products and/or processing characteristics could show some interactions. Supporting or conflicting each other, they could influence the producer strategy. The integration of other sensorial aspects into the product quality attributes might also be considered as an interesting option, to investigate more deeply the role of the processing requirements on the perceived cheese quality.

<sup>1</sup> E.g. relative weight of genotype lines =  $424.2 / (424.2 + 453.4 + 496.8 + 428.5 + 403.8 + 239.5 + 195.6 + 254.3 + 288.7) = 13.3\%$ .

## Conclusions

This study analyses some of the quality determinants of pecorino cheese as viewed by different points of view. Both the demand and the supply side determinants of the quality of organic pecorino cheese are considered. The results of our study show how consumer choices can have an influence on the production phase and on the farming strategy, and vice versa. There is a need to re-connect the producers with their consumers, to reduce consumer anxiety (e.g. food scares) and to better support the producers. Animal welfare and local origin (of the cheese production) are not only a need for the consumer, but also an opportunity for producers who are interested in improving their product.

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## References

Akao, Y. (1990): *Quality function deployment*. Productivity Press, Cambridge MA, 371 pp.

Almli, V.L., Naes, T., Enderli, G., Sulmonet-Rossè, C., Issanchou, S., Hersleth, M. (2011): Consumers acceptance

of innovations in traditional cheese. A comparative study in France and Norway, *Appetite*, 57: 110-120.

Benner, M., Linnemanna, A.R., Jongena, W.M.F., Folstara, P. (2003): Quality Function Deployment (QFD) – can it be used to develop food products? *Food Quality and Preference*, 14: 327-339.

Guerrero, L., Guàrdia, M.D., Xicolaa, J., Verbeke, W., Vanhonacker, F., Zakowska-Biemans, S., Sajdakowska, M., Sulmont-Rosséd, C., Issanchoud, S., Conte, M., Scalvedie, M.L., Granlif, B.S., Hersleth, M. (2009): Consumer-driven definition of traditional food products and innovation in traditional foods. A qualitative cross-cultural study, *Appetite*, 52: 345-354.

Hauser, J. R., Clausing, D. (1988): The House of Quality. *Harvard Business Review*, 66: 63-73.

Napolitano, F., Braghieri, A., Piasentier, E., Favotto, S., Naspetti, S., Zanolli, R. (2010): Cheese liking and consumer willingness to pay as affected by information about organic production, *Journal of Dairy Research*, 77: 280-286.

Vatthanakul, S., Jangchud, A., Jangchud, K., Therdthai, N., Wilkinson, B. (2010) Gold kiwifruit leather product development using Quality Function Deployment approach. *Food Quality and Preference*, 21: 339-345.

Zanolli, R., Scarpa, R., Napolitano, F., Piasentier, E., Naspetti, S., Bruschi, V. (2012): Organic label as identifier of environmentally related quality: a consumer choice experiment on beef in Italy. *Renewable Agricultural and Food Systems* (forthcoming).