Sensory characterisation of the

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Sensory Characterisation of the Toma Piemontese

In order of the *Hogeschool Delft* and *Universit degli studi di Torino, settore microbiologia a industrie agrarie.*

Coordinators:

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PREFACE

This research has been performed by order of the *Hogeschool Delft* and the *Università degli studi di Torino (DI.VA.P.R.A settore Microbiologia e Industrie Agrarie*).
With the help of the *Erasmus* organisation it has been possible to accomplish a training period in Italy.

In this training period I processed, with the support of my italian coordinator Dott. G. Zeppa, the sensory characterisation of 22 samples of the *Toma Piemontese*. In a primary project researchers had analysed 44 samples of *Toma* cheese. The results of this project are also performed in my research.
In correlation with the results of the study of the sensory characteristics there had been microbiological and chemical analysis. These analysis had been examined in a special laboratory for research of dairy products.

The proces of this research had not always been comprehensible. Most information about the *Toma Piemontese* has been written in italian. This caused some problems with understanding the main points, however I managed to finish this research about the *Toma Piemontese* with pleasure.

This training period has been very instructive and this experience will be remberbered day after day.
I want to thank the people that supported me. In particular my coordinator Dott. G. Zeppa, he coached and advised me during this period, and my colleagues of the Agricultural University in Grugliasco.

Grugliasco, 10 april 1998.

SUMMARY

The sensory characterisation of 66 samples of the *Toma Piemontese* have been processed. The aim is the sensory characterisation of 66 samples of the *Toma Piemontese* and the research of the correlation between the sensory characteristics and the results of microbiological and chemical analysis.

Panelist have been able to give a valutation of these 66 samples in a sensory test. In total there have been 9 sensory tests, where each sensory test has been divided into two sections. The first section is a test which include the aroma, texture and taste of the samples. The second section involve the eyes (holes) and the colour of the samples, were the panellist have to give a valuatation of the quantity, largeness of the eyes and the colour intensity, uniformity of the cheeses.

With the help of statistical analysis a scatter-plot matrix has been used to see if the sensory descriptors showed a correlation among eachother. This figure confirmed no correlationship among the descriptors.

The results of the cluster analysis have been represented in a dendogram. With this dendogram it had been possible to group the 66 samples into three principal clusters indicated as A, B and C. The cheeses of cluster A distinguish onself of the samples of the other clusters, because of the value of producers categorised in the dairy industry. The difference of the production is the use of a starter for the acidification of milk.

A spider-web diagram show that the panelists prefer cheeses first of cluster A, than cluster C and at least cluster B. The cheeses of cluster B show a some defects because of the high mark of proteolyse and lipolyse.

The average of the microbiological and chemical analysis of the samples grouped in the clusters A, B and C has been used to compare the results of the clusters among each other. Some results have been in agreement with the sensory test. Though when the average of the 66 samples is used, the most values come close to cluster B, which have the lowest preference of the panelists.

The sensory characterisation *of Toma Piemontese* is typical, because this characterisation has not been depend on technological parameters or production variables, but it is dependent on the interaction of these factors and the producer that produce a good *Toma Piemontese*.

CONTENTS

CHAPTER 1 INTRODUCTION

One of the most well known cheese in the district of Piedmont is the *Toma Piemontese*.
Toma Piemontese is a special name for several typical cheeses with corresponding production methods, however each type of cheese is different.
Since there has been a lot of differences among the *Toma* cheeses, the Region Piemonte started in 1995 a study of the sensory and technical characterisation of the composition of the *Toma Piemontese*, involving the products of about hundred producers.
Though all the*Toma* cheeses showed different characteristics, it has been possible to divide the products into five categories (which not mean that the characteristics among the *Toma* cheeses of one category have been totally the same). Some producers, which couldn't be classified in on of these five categories, are grouped in category 0.
Attention has been payed to several aspects, like production methods, sensory-, technological-, microbiological- and chemical characteristics of the cheeses.
The division of the five categories are:

1 Dairy industry (caseificio)
2 Traditional
3 Traditional without skimming
4 Traditional without pressing
5 Biellese

Despite the division of the cheeses in categories, the producers still using their interpretation which can be refered to the differences among the investigated samples of the *Toma Piemontese*.

The sensory characterisation of *Toma Piemontese* has been performed for 66 samples, of wich 44 samples were examined in 1995 and 1996 and 22 samples in 1997 and 1998.

The purpose of this research is the sensory characterisation of the 66 samples of *Toma Piemontese* and the study of the sensory characteristics in correlation with the microbiological and chemical compositions.

Understanding that the *Toma Piemontese* can show so many differences among each other, it is better to consider each *Toma* cheese as a specific kind of cheese.

CHAPTER 2 THE "TOMA PIEMONTESE"

The *Toma Piemontese* represent an important typical product of the region Piedmont (*Regione Piemonte, 1998*). In 1964 this cheese has been obtained the D.O.P. (Protected Origin Denomination) by the Italian Ministry of Agriculture.

This chapter has been writen to give more background information of the hystory and the used production techniques of the *Toma* cheese.

2.1 Hystory

Cheese is one of the main products of the transformation and fermentation of milk.
For many ages people used fermented milk for the production of cheese, butter or other dairy products. These habbits have been inherited from generation to generation. This happened also with the produce of *Toma* cheese. Every individual proprietor has and uses his own recipes and standards for the produce of *Toma* cheese, probably this is why the characteristics of this cheese have many differences. Though you can recognize similarity between the production methods.

In a book called *Summa lacticiniorum* , that dates back to 1477, is writen the primarily information about the quality of milkproducts, a description of cheese from several countries and the first characteristics problem of cheese (= also called *casio*). This year *1477* confirm the production of the *Toma* cheese, only people didn't called this type of cheese *Toma*. In those days the people used to call the cheese after the place of origin, for exemple "*cacio di Val di Lanzo*".

The first time that the name *Toma* was used, was in the seventeenth century.
People use the name <*Toma*> to point at the specific form, taste and colour of this cheese.
In fact the name <*Toma*> is given to a number of small and larges cheeses of various degrees of ripening, different look, aroma and taste -from sweet to tangy to very sharp (*Unalat,1992*).
Many dictionarys define *Toma* as a sort of fresh cheese with a small dimension. For example Zalli wrote <<*Toma*= sorta di cacio formato recentemente con latte rappigliato insieme e premuto; cacio fresco, caseus recens, fromage frais, fromage blanc. *Toma grassa a la fior*, cacio fresco col fior di latte ... fromage frais à la crême, fromage non écrêmé. *Toma 'd formag*, forma di cacio>> (*Regione Piemonte, 1998*).

2.2 *Piedmont and the area of production of the "Toma Piemontese"*

The region Piedmont can be found in the nord of Italy. This region, were people produce the *Toma Piemontese,* has been divided into eight provinces. The greater part of the producers can be found in the Alpine valleys of the provinces of Torino, Novara, Vercelli and Cuneo (*Regione Piemonte, 1993*).

Figure 1 show the origin places of the investigated cheeses. The producers of these samples have been grouped with the number of one of the five categories.

Only category five belongs to a specific area. The categories 2, 3 and 4 have been grouped in several area's and category 1 have been spread over almost the whole area of Piedmont.

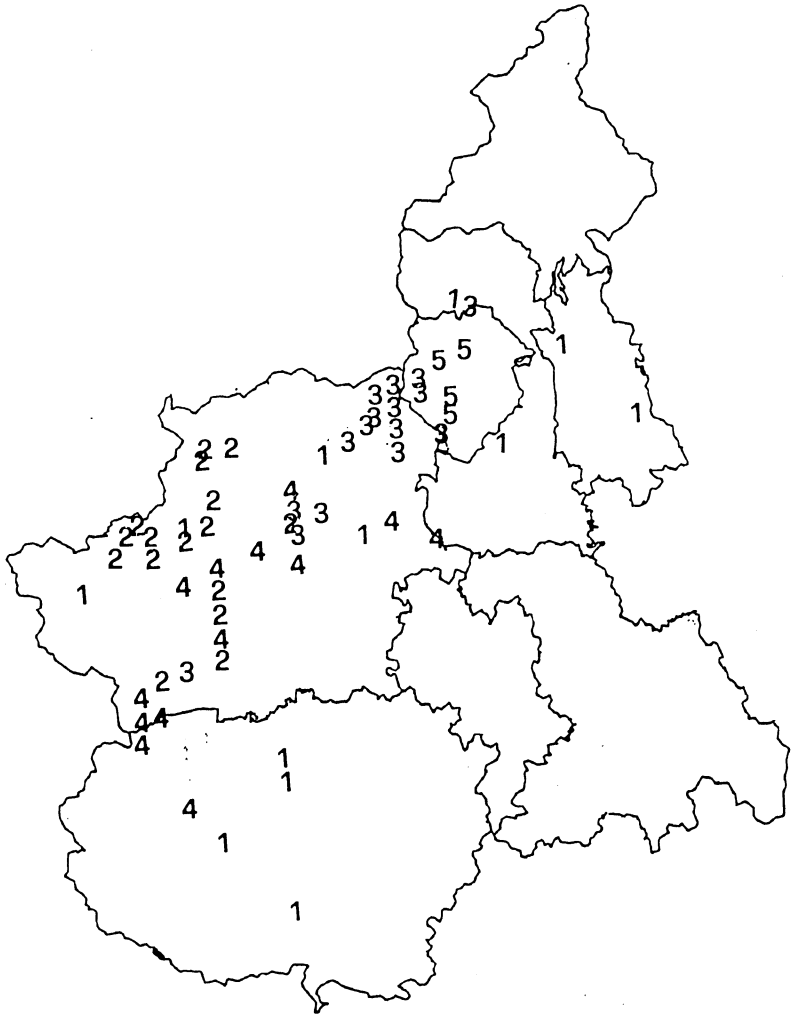

Figure 1: The area of production of the *Toma* cheese with their category in region Piedmont (1: Dairy industry - 2: Traditional - 3: Traditional without skimming - 4: Traditional without pressing - 5: Biellese).

2.3 *Production*

Figure 2 shows a general flow sheet with the most important steps for the production of *Toma* cheese (Kosikowski, 1982). In accordance with this flow sheet the terms will be explained:

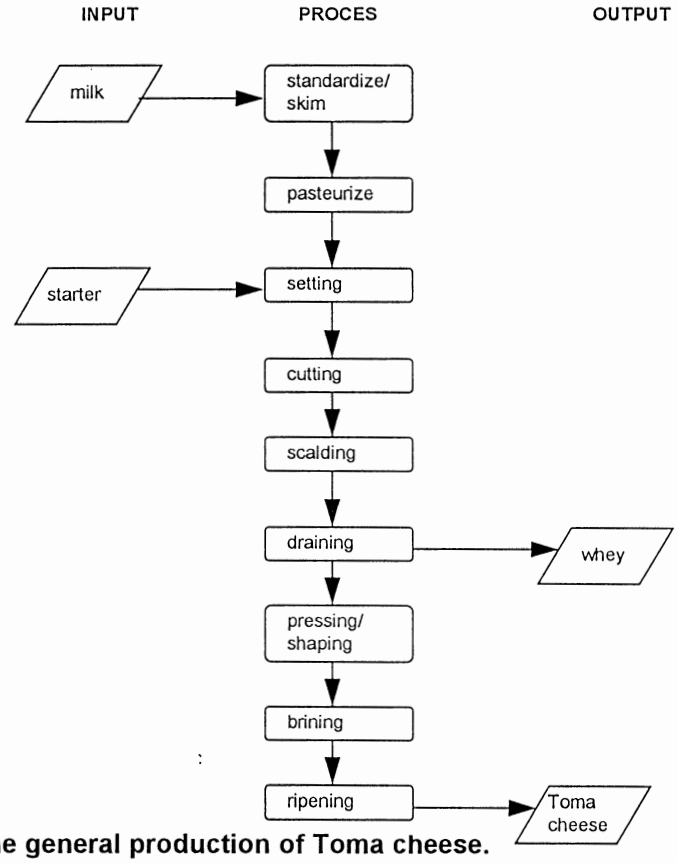

Figure 2: Flow sheet of the general production of Toma cheese.

1) Skimming or standardizing

There is a lot of difference among the techniques of production to standardize milk. The use of different kettles can effect the fat content of milk. Another point that effects the fat content is the quantity of removed fat.

2) Pasteurize and the use of a starter

In general dairy industries pasteurize their milk before producing, to have a longer date of consumation. With pasteurisation a product is heated for 20 seconds at 72°C.

One main difference between the other categories is the use of a starter. The industrial producers distinguish oneself by the use of a starter, but also a few producers with a little daily produce make use of a starter.

3) Scalding (1) after setting and scalding (2) after shaping

Their are two types of scalding, the difference is the function.

Scalding 1: Curd is heated after setting, to get a better separation of whey and curd. Because of the low water content the curd will become more hard.

Scalding 2: After shaping the cheese is heated to maintain the liquid substances. This effects the texture of the cheese, but the main purpose is an economical aspect; the cheeses have more volume and a higher weight.

4) Pressing and shaping

The main purpose of pressing is getting rid of the liquid components (most of all whey) inside the cheese. With pressing the cheese become more compact and shaped in the form of the used mold. Not every producer make use of pressing

5) Brining

This aspect is not only to give the cheese a special flavour, but it has also microbiological reasons such as reduction of the microflora.

When cheese is salted the outer layer gets a high percentage of salt, microorganism have no change to survive in this environment.

Brining can be divided into two techniques:

A: The use of a salt solution (Fig. 3).

B: Manual brining; solid salt is put on the outer layer of the cheese (Fig. 4)

The difference between these techniques is the homogeneous salt concentration. In a kettle with a salt solution the concentration is uniform at every place. The uniformity of the second technique is less, but in general this technique is carried out by "professional" cheese producers and they know how to divide the salt to get a homogeneous concentration.

6) Ripening

This step can also be called maturation of the cheese. How longer the maturing how more the cheese become fracturable, like Grana Padano or Parmigiano Reggiano (1 - 3 years). The cheeses for this research have a ripening of 30 days, which means that they are rather fresh and soft. Figure 5 shows a ripening room of the *Toma Piemontese* of Valle Josina.

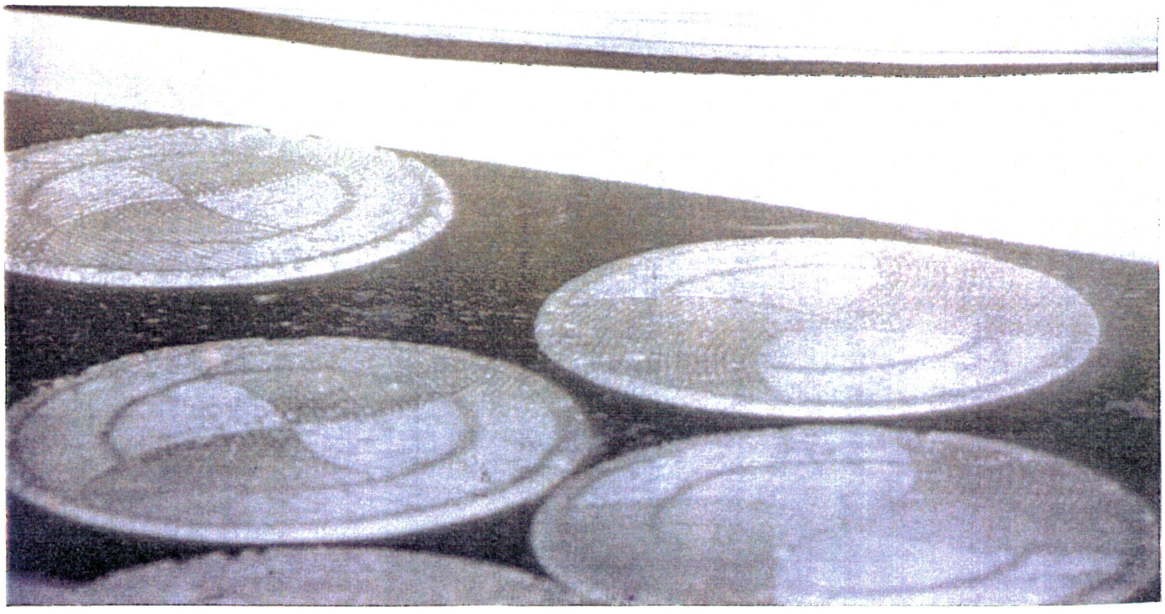

Figure 3: Brining with the use of a salt solution

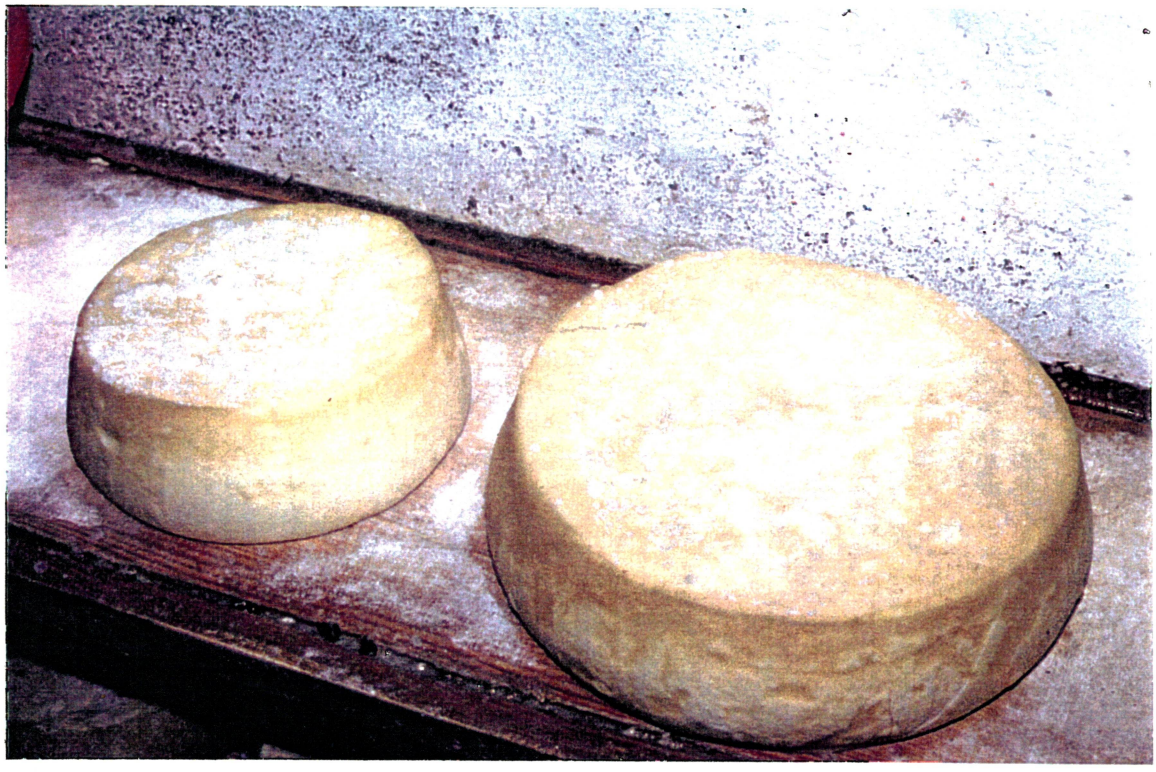

Figure 4: Brining with the use of solid salt.

Figure 5: A ripening room of *Toma* cheese of Valle Josina.

Some differences between the five categories can be seen in a flow sheet of the cheese production (Fig. 6), however every producer of the *Toma Piemontese* uses their own interpretations and techniques for the produce of *Toma* cheese. Some producers couldn't be grouped in one of the five categories, these producers are classified in category 0.

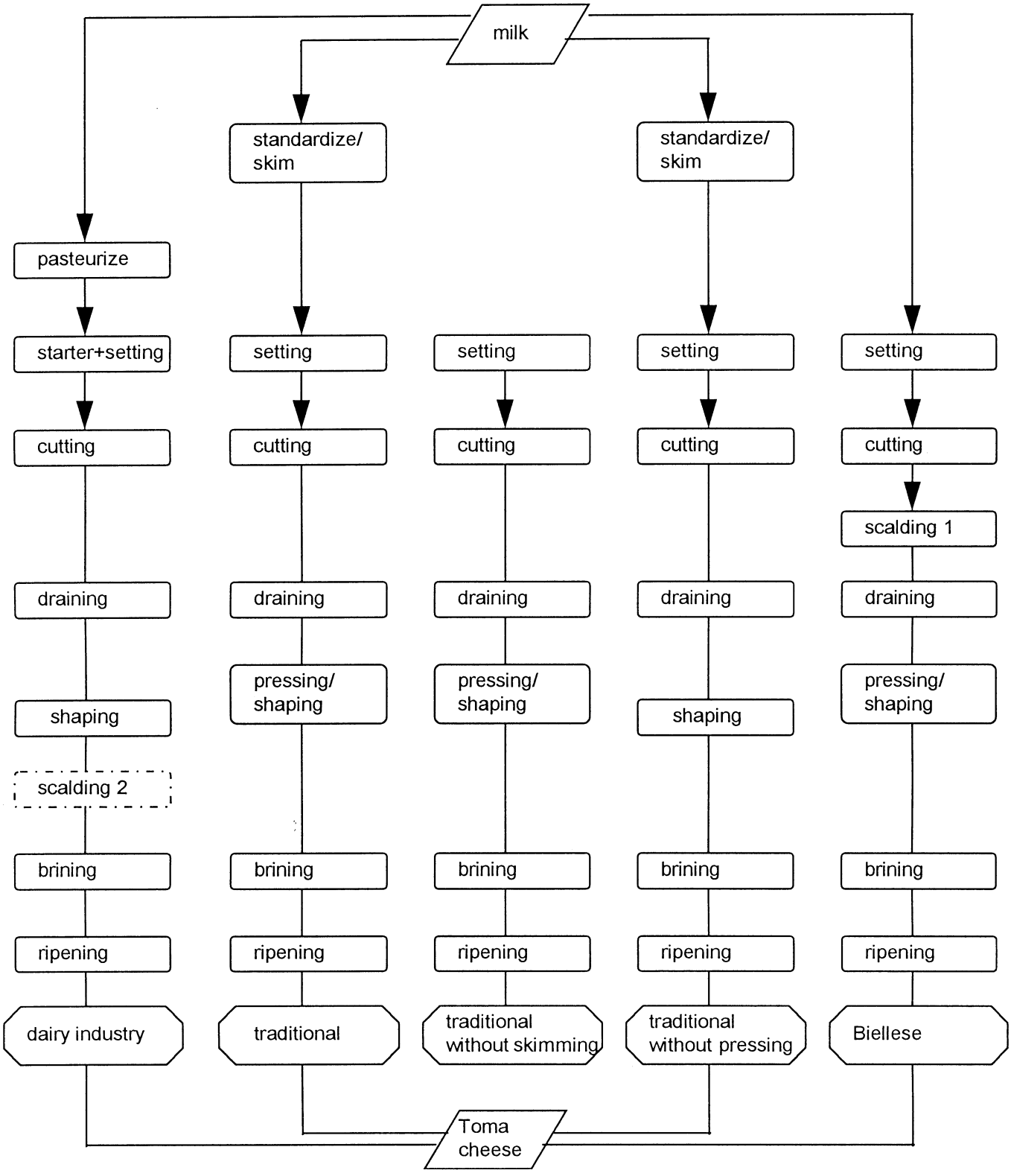

Figure 6: Flow sheet of the production of *Toma* cheese with the difference between the five categories.

2.3.1 *Dairy industry*

In general the producers of this category make use of fresh milk that is not skimmed. Before producing cheese the milk is pasteurized, to have a longer consuming date.
A main difference in comparisson with the other producers is the use of starters for the acidification of the milk.
Most of the producers don't press there products. Some producers have semiscalding after shaping for a higher weight of the cheese.
The step shaping is followed by brining and ripening, these techniques count for every classification.

2.3.2 *Traditional*

Before produce the milk is skimmed and for the following treatments raw milk is used.
After setting the curd is pressured and shaped.

2.3.3 *Traditional without skimming*

The techniques used for this production are almost the same as the traditional production, only these producers don't skim their milk before produce.

2.3.4 *Traditional without pressing*

The difference between this category and the other traditional categories is the step pressing. These producers don't use the technique pressing, only shaping.

2.3.5 *Biellese*

This category distinguish oneself of the other four.
The production of cheese is right after milking of the cows.
As one can see there is no treatment on the milk before setting, right after setting and cutting the curd is scalded (to heat). This technique is followed by pressing/shaping, brining and ripening.

CHAPTER 3 MATERIALS AND METHODS

The analysis used for the research of the *Toma Piemontese* is in accordance with specific standardized norms called FIL - IDF (Federatione Internationale de Laterie -International Dairy Federation).

3.1 Microbiological analysis

The techniques used for the microbiological analysis are all international normalized. Only four (the most important) microorganism have been analysed, involve *Staphylococcus aureus*, coliforms, *Lactobacillus sp* and *Streptococcus sp.*. With the help of these analysis a clear understanding can be afforded by the explanation of the sensory characteristics, for example a high mark of acidity can be caused by the quantity of *Lactobacillus sp.* and *Streptococcus sp.*.

Staphylococcus aureus

The detection of *Staphylococcus aureus* has been carried out in accordance with the norm *FIL 145:1990*. This norm can also be used for the determination of *Staphylococcus sp.*: coagulase +.

Definition: *Staphylococcus aureus* can be present if the sample shows black coloured colonies after an incubation at 37°C during 24-48 hours. These black coloured colonies are transplanted at a medium of Baird-Parker and incubated at 42°C during 24 hours. The specific colonies which arose from the second incubation are isolated. For confirmation *Staphylococcus aureus* gives a positive reaction at the coagulation test.

Coliforms

The count technique for coliform colonies obtained at 30°C followed the AFNOR norm *V 08-050:1992*.

Definition: One can detect the coliforms after incubation at 30°C during 16-24 hours on a selective medium. If necessary there is a pre-incubation during 2-8 hours for the development of the bacteria, which are able to form gas out of lactose.
This method is based on MPN-reaction, the result of the first incubation show the presence of total coliforms and the second incubation show the number of the fecal coliforms.

Lactobacillus sp. and *Streptococcus sp.*
For the identification of *Lactobacillus sp.*and *Streptococcus sp.*in cheese products the norm *FIL 146:1991* can be used, although this norm refers to yogurt.

Definition: The colonies of the *Lactobacillus sp.* are the colonies which apear after incubation of the sample at 30 C during 3-5 days on a medium of MRS.
For determination of *S. salvarius subsp. thermophilus* the sample has to be incubated for at least 24 hours at 37 C. The colonies of *S. salvarius subsp. thermophilus* are catalase negative.

3.2 Chemical analysis

To develop a clear understanding of the products involve chemical analysis. The most important techniques of analysis of *Toma* cheese are: pH, dry substance, protein and fat content analysis. Other important analysis are sodium chloride, D-lactic acid/ L-lactic acid, titratable acidity and soluble nitrogen.

pH measuring
Material: pH-meter which has a pin with a sensor
buffersolution with pH = 4
buffersolution with pH = 7
Toma cheese sample

Method:
The sample has to have a thickness of 2 cm. Calibration of the pH-meter is taken by means of the two buffersolutions with pH = 4 and pH = 7.
Stab the pin into the sample and measure the pH when the value is stable.

Dry substance (in %)
Material: special heating apparatur with scale
aluminium plates
homogeneous mixed sample

Method:
Take an aluminium plate and put it on the scale of the heating apparatuur. Adjust the temperature to 130 C.Tar the scale and measure about 3,00 grams of the homogeneated sample on the plate. It is important to spread the sample over the entire surface of the plate. The reading starts at 100%. Close the cover and record the percentile until the reading is stationary.

Protein

For this procedure FIL-IDF 20 B method (*FIL-IDF, 1993*) is used.

This procedure has been modified, instead of adding 10 ml of sulfuric acid, add 15 ml sulfuric acid.

Fat content

To determine the fat content in cheese the method of the Gazzetta Ufficiale (*DM, n° 88 del 21 aprille 1986*) is used.

Fat content means the value of pure fat and fatty substances.

The principle of this method is the hydrolisation of a cheese sample, hydrochloric acid and ethyl alcohol, followed by an extraction with a solution of alcoholacid which contents ethylether and petroleumether. The liqued substances are vaporised. After a heating proces the sample is weighed.

Sodium chloride

For the analysis of the content of sodium chloride the norm *FIL-IDF 17: 1961* is used.

This procedure is based on the destruction of the organic material of cheese with potassium permanganate and nitric acid followed by the detection of the amount of chloride, titrated with silver in a solution with nitric acid. Iron (III) ammoniumsulfate is used as indicator.

D-lactic acid and L-lactic acid

For the determination of D- and L-lactic acid in foodstuffs and other materials a special UV-method is used (*Boehringer Mannheim, 1995).*

Titratable acidity

This procedure is similar to the one reported in Gazzetta Ufficiale (*DM, n° 88 del 21 aprille 1986*).

The principle is based on a suspension of water and cheese which will be filtrated. After the filtration, add a view drops of phenolphthalein and titrate with sodium hydroxide.

Soluble nitrogen

The documentation used for this analyse is also repported in the Gazzetta Ufficiale Ufficiale (*DM, n° 88 del 21 aprille 1986*).

This method is almost similar to the method used for Kjeldahl. The difference is the first part.

A suspension of the sample with water has been made and after 12 hours the total suspension is filtrated. When this proceeding is accomplished, follow the norms of the methods for Kjeldahl (*FIL-IDF 20B:1993*).

3.3 Sensory analysis

An important subject for the research of characteristics of the *Toma Piemontese* is sensory analysis.
The test results of this research are related with the microbiological and chemical results.. When relating sensory and chemical/physical data rationalising sensory data prior to attempting to identify relationships improves the chance of getting meaningful results (*Williams et al., 1988*).
At least all the results are converted with behelp of statistical analysis.

The principal points of sensory analysis to research the characteristics of alimentary products are:
- identification of the descriptors;
- training of panelists;
- examination of the products.

3.3.1. Identification of the descriptors

The first part of a sensory research is to identify the descriptors. These descriptors are put together by a commission of almost twenty tasters of wich the greater part already had experience with sensory analysis.
The results must be described precisely and without discrimination, this involve also the examination of the tests products wich are in accordance with profile UNI ISO 6564-6658.

In this research the commission examined about 10 sample of cheese with a ripening time of 30 days at each sensory test. For the identification of the descriptors a "free" descriptive schedule (Fig. 7) has been used. On this schedule it is possible to write your personal descriptions of a sample.

The classification of the descriptors had been gathered gradually. In the primaire stage there were hundred descriptors present. Every descriptor with resemblance has been reduced to one pair. At the least the value of hundred descriptors has been reduced to 27. With these descriptors two schedules are formed:

1) aromas, texture and taste (Fig. 8);
2) eyes and colour of the *Toma* cheese (Fig. 9).

The meaning of the descriptors in English are performed in appendix 1.

Scheda descrittiva libera

Degustatore: ..... **Data:** .....

Riportare per i diversi campioni i sostantivi che meglio descrivono il prodotto in esame. Si prega di scrivere in stampatello.

Campione .....

Campione .....

Campione .....

Figure 7: Discriptive schedule "free" for identification of the descriptors (*Regione Piemonte, 1998*).

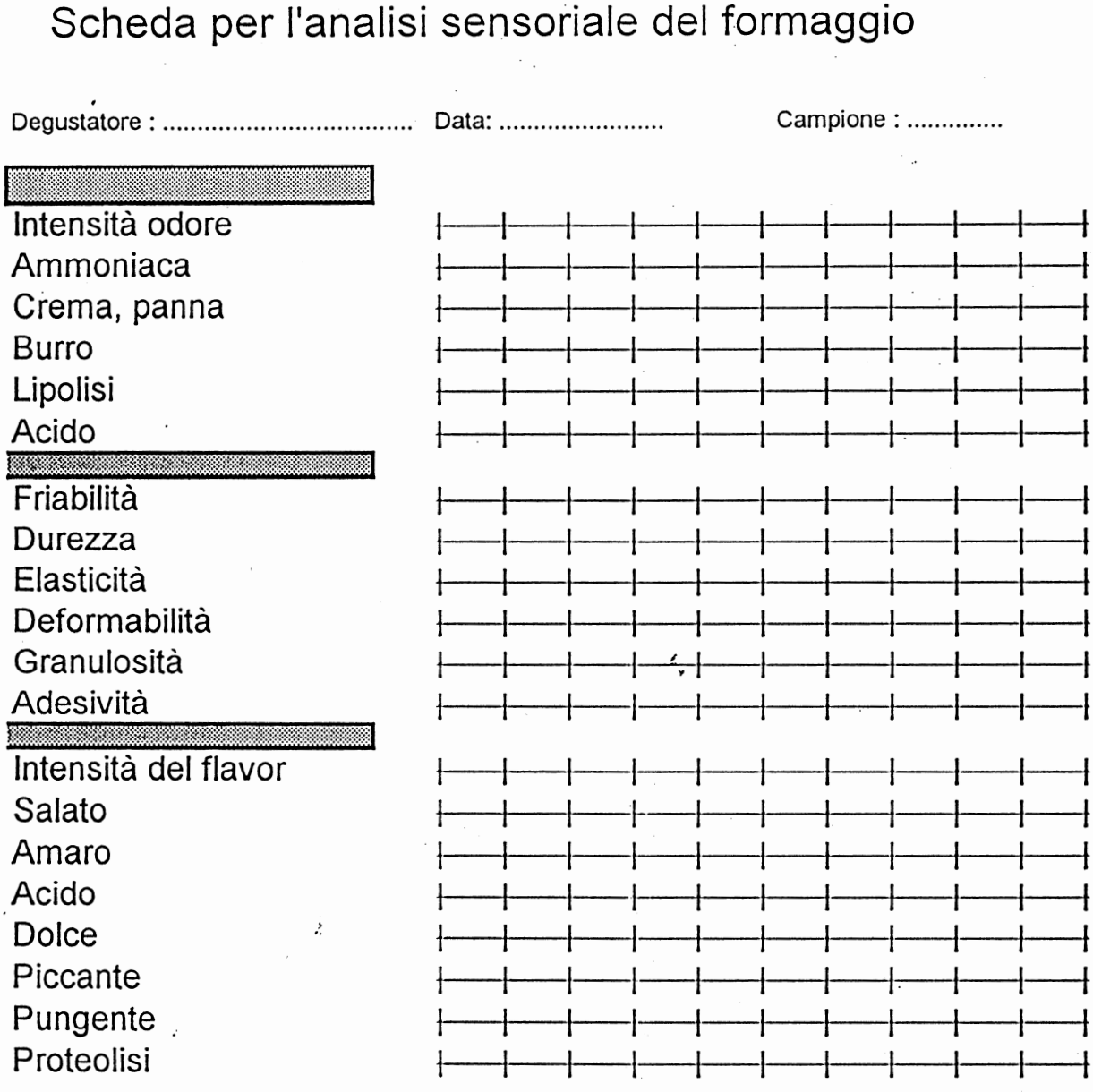

Figure 8: Card 1 for the description of the quantity of aroma, texture and taste of the *Toma Piemontese* (*Regione Piemonte, 1998*)

Scheda per l'analisi sensoriale del formaggio

Data: .... Degustatore : ....

Campione n.

Spessore crosta /--/

Uniformità colore pasta /--/

Intensità del giallo /--/

Distribuzione regolare degli occhi	SI	NO				
Forma regolare degli occhi	SI	NO				
Dimensioni degli occhi (mm)	<1	1_2	2_3	3_4	4_5	>5
Numero di occhi (su 10* 5 cm)	<10	10_50	50-100	>100		

Campione n.

Spessore crosta /--/

Uniformità colore pasta /--/

Intensità del giallo /--/

Distribuzione regolare degli occhi	SI	NO				
Forma regolare degli occhi	SI	NO				
Dimensioni degli occhi (mm)	<1	1_2	2_3	3_4	4_5	>5
Numero di occhi (su 10* 5 cm)	<10	10_50	50-100	>100		

Campione n.

Spessore crosta /--/

Uniformità colore pasta /--/

Intensità del giallo /--/

Distribuzione regolare degli occhi	SI	NO				
Forma regolare degli occhi	SI	NO				
Dimensioni degli occhi (mm)	<1	1_2	2_3	3_4	4_5	>5
Numero di occhi (su 10* 5 cm)	<10	10_50	50-100	>100		

Campione n.

Spessore crosta /--/

Uniformità colore pasta /--/

Intensità del giallo /--/

Distribuzione regolare degli occhi	SI	NO				
Forma regolare degli occhi	SI	NO				
Dimensioni degli occhi (mm)	<1	1_2	2_3	3_4	4_5	>5
Numero di occhi (su 10* 5 cm)	<10	10_50	50-100	>100		

Figure 9: Card 2 for the description of the quantity of eyes and colour of the *Toma Piemontese* (*Regione Piemonte, 1998*)

Card 1

This card is specific for aroma, texture and taste of a sample.

To understand the descriptor texture, it is useful to know a definition about texture:

Texture: The attribute of a sustance resulting from a combination of physical properties and perceived by the senses of touch (including kinaesthesis and mouthfeel), sight and hearing. Physical properties may include size, shape, number, nature and conformation of constituent structural elements.

Texture is defined as a sensory attribute and so only measurable directly by sensory means (*Brennan, 1988*).

As one can see on card 1 every descriptor has been subdivided in ten parts on a horizontal line without indicating a relative valour. This horizontal line is only a reference for the panelists so that they can give a quantitative value.

Card 2

Card two refers to the eyes and colour uniformity of the cheese.

To avoid influence, the panelist already has done the first examination before testing this type of sensory examination.

Every cheese sample of this sensory test must have the same circumstances. Another requirement is the size of the samples, each has got a dimension of 10*5 cm. After sampling the cheeses are each put on a white plate (Fig. 10). All these conditions are to prevent any influence.

Figure 10: Example of a presentation for the visual examination of 6 samples of *Toma* cheese.

The valutation of the eyes (holes) and the aspect of the pulp have not got a subdividing of the descriptors. For these analysis a non parametric scale is used. This scale provides a questionnaire respons of the remained descriptors <<*Spessore crosta, uniformità colore pasta, intensità del giallo*>>.
The questions "*distribuzione regulare degli occhi*" and "*forma regulare degli occhi*" can only be answered by YES or NO.
The dimension and number of the eyes are quantitative parameters, but is difficult to measure these values if one uses the same scale as mentioned before. The optimal solution is to take measurable values with intervals, from 1 to 5 mm for the dimension of the eyes and from 10 to 100 for the number of the eyes, these are to be seen in card 2.

3.3.2. Training of panelists

The second part of a sensory research is to train the panelists for tasting according to the international standarized norms for sensory analysis (ISO 3972 - 5496- 8586/1 - 8586/2).
This training last for approximately 10 hours. In this period the panelists learned to give a value to the descriptors of arome texture and flavour, like the quantity of arome is 8, this cheese is sweet or less sweet etc.
Another important point before analysing was the valutation of the quantitative aspect of the pulp and eyes. What is the intensity of the colour of the pulp, when do the eyes have a dimension of 3_4 mm, or when is the number of eyes between 50 and 100.

Usually it is reasonable to repeat these test before a sensory test takes place, unfortunately for this research it was impossible.

3.3.3. Examination of the Toma Piemontese

The sensory characteristics of *Toma* cheese have been carried out by almost twenty tasters according to the norm UNI ISO 8915.

In a Regional Project of 1995 and 1996 panelists examined 44 *Toma* cheeses. These 44 samples had been divided in 6 sensory tests. For this research 22 samples have been tested, spread over 3 sensory tests. The total of 66 samples have been processed in this work.
The conditions of every sample have to be the same with each examination, this involve ripening, package, storage, preparation and testing.
The Toma cheese samples have to be bought between 1 and 3 days before the sensory test takes place and the ripening period has to be between 30 and 35 days. The first package of the samples is paper, the second is a plastic bag. The samples are stored in a refrigerator with a temperature of +2 °C.

The day of the sensory tests all the samples are prepared with the same technique. The samples are cut into cubes of 1 cm by 1cm and approximately 6-8 pieces are put in screw cap containers with the matching number of the cheese samples.
This preparation takes place in a different place than where the panel has their sensory test.

In the examination "room" (Fig. 11) each member of the panel gets three examination cards. After each sample the panelists have to clean the persistence of that sample with water and crackers, this is also for avoiding flavour adaptation of the samples.
At least it is important that each panelist gives their valutation of every sample between 0 and 10 to have a hedonic result.

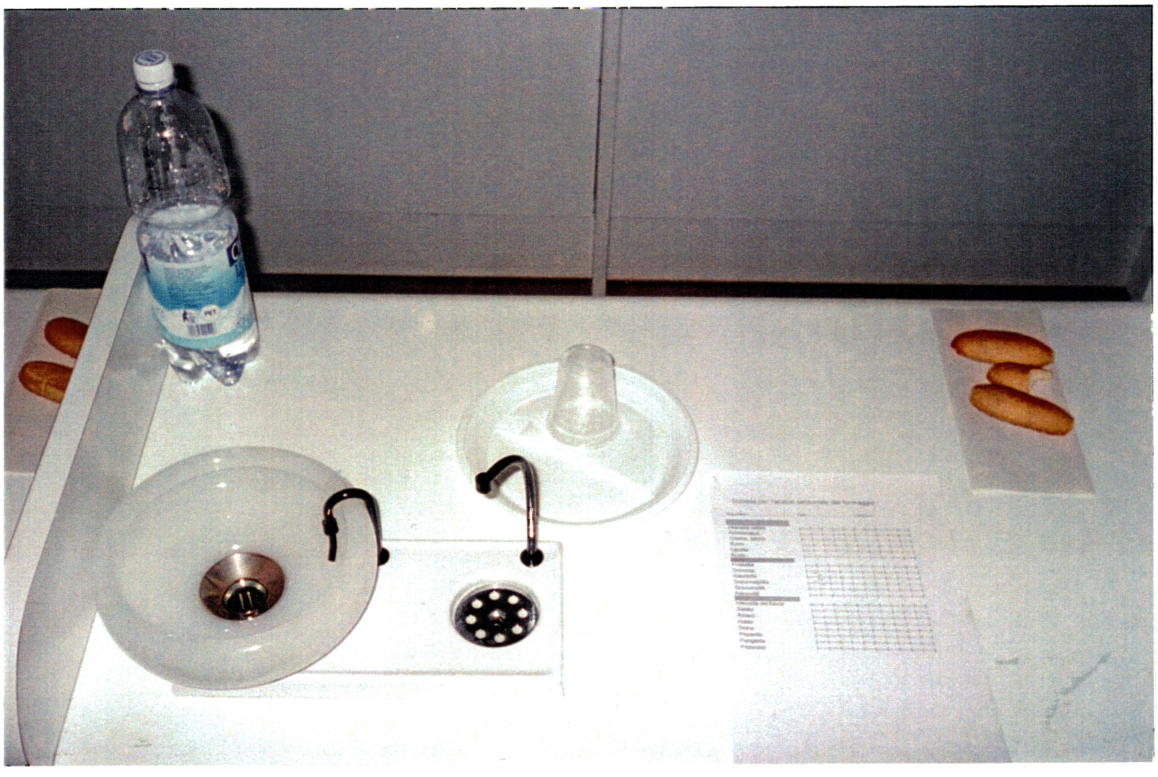

Figure 11: Example of an examination "room" for aroma, texture and taste of *Toma* cheese.

3.4 Statistical analysis

All the statistical results are performed by SPSS version 5.02 and STATISTICA for Windows.

The results of the sensory tests the median have been calculated for all samples. For this research the average has not been used because of the influence of the highest and lowest valutation.

CHAPTER 4 RESULTS AND DISCUSSION

The calculated median values have been analysed for every sample with the multivariance statistical analysis.

Figure 12 represent a scatter-plot diagram which can show a relationship that exists between the sensory parameters. This matrix allows all of the pairwise plots of the data to be displayed in a compact format (*Meilgaard, 1991*).
This matrix show several bi-plots. If the points in one bi-plot refer to a diagonal; the descriptors have a correlation. A increasing diagonal gives a positive effect on the perception, a decreasing diagonal gives the opposite (negative perception). When the points have been spread over the total area of the bi-plot, it refers to no correlation.
For example: one can see a positive correlation between the descriptors *Ammoniaca* and *Lipolisi* or *Piccante* and *Pungente*. An example of a negative correlation is between the descriptors *Friabilità* and *Deformabilità*.

The primary technique which is used, have been the Principal component analysis (PCA). PCA is a dimension-reducing technique, whose purpose is to transform the original variables into a new set of principal components, wich are uncorrelated with each other and whose variances decrease (*Smith, 1988*). When there exists no correlation between the sensory parameters, which can be seen in the scatter-plot diagram, the variance explicate that the first two factors have been inferior to 30%. For this reason the PCA is not been able to interpret the sensory results and the distribution of the cheese samples.

For describing the sensory characterisation of the examined cheeses the cluster analysis have been used. The cluster analysis is performed by Ward methods and is represented in a dendogram (Fig. 13 and 14). This method is usefull for the classification of cheeses by descriptions of sensory characteristics or evaluation of their similarities to each other (*Smith, 1988*).
The dendogram is a graphical system to represent the similarity between samples. When two samples show similarity the distance between a cluster is little. If the distance increases between the clusters also the dissimilarity increases.
The dendogram of figure 13 can be divided into two principal clusters. The first cluster have been grouped by the samples between 2 and 24 and the second by the samples between 33 and 39. The second cluster contain two cluster, one cluster has been grouped between the samples 33 and 12 and the other cluster have samples between 22 and 39. Then the dendogram point out the presence of three sub clusters, which are indicated with A, B and C.
The categorisation of the producers is performed in appendix 2. Figure 14 show the same dendogram as figure 13 but this one have been numbered with the categorisation of the samples.

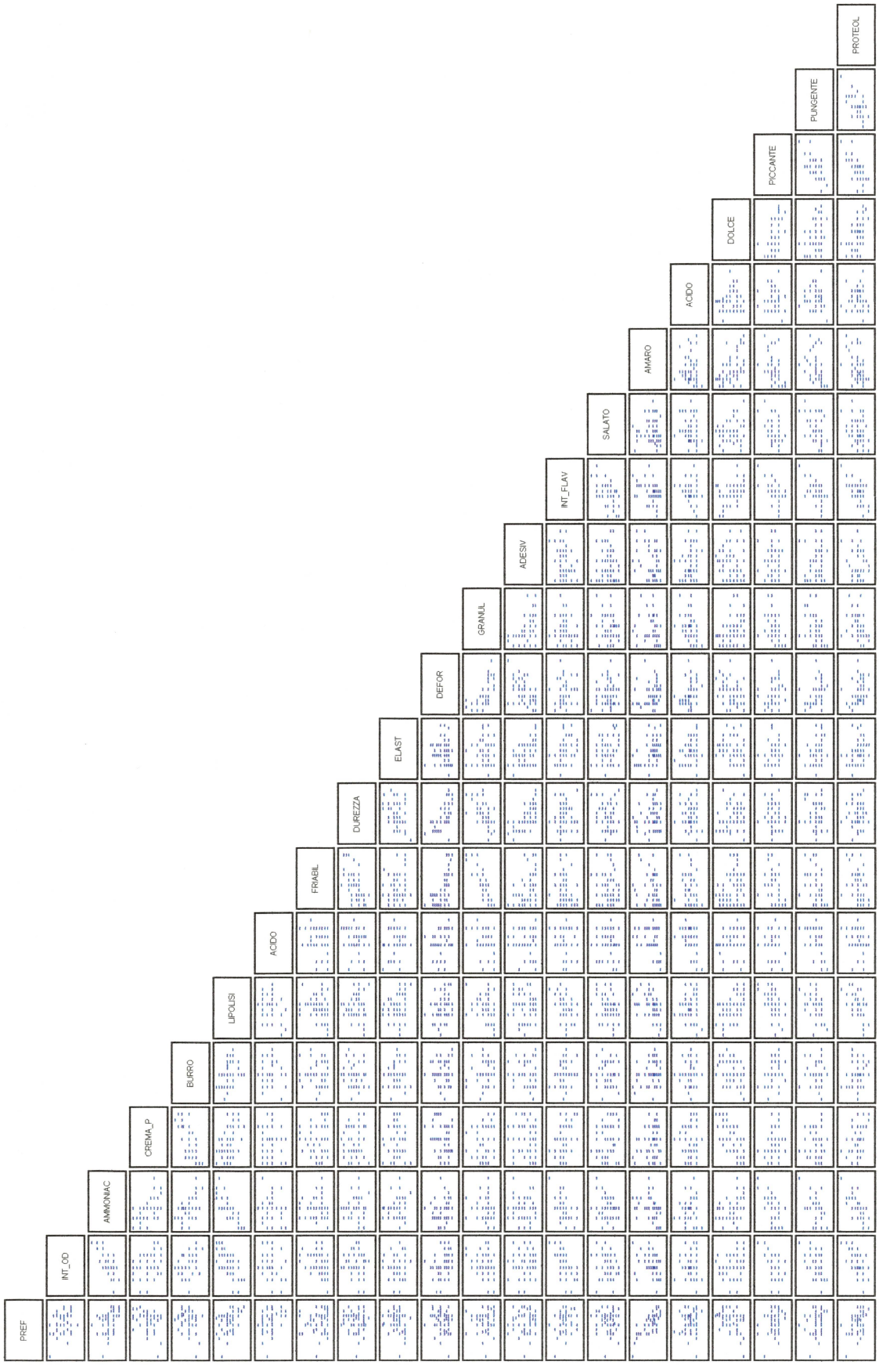

Figure 12: Scatter-plot diagram of the sensory descriptors.

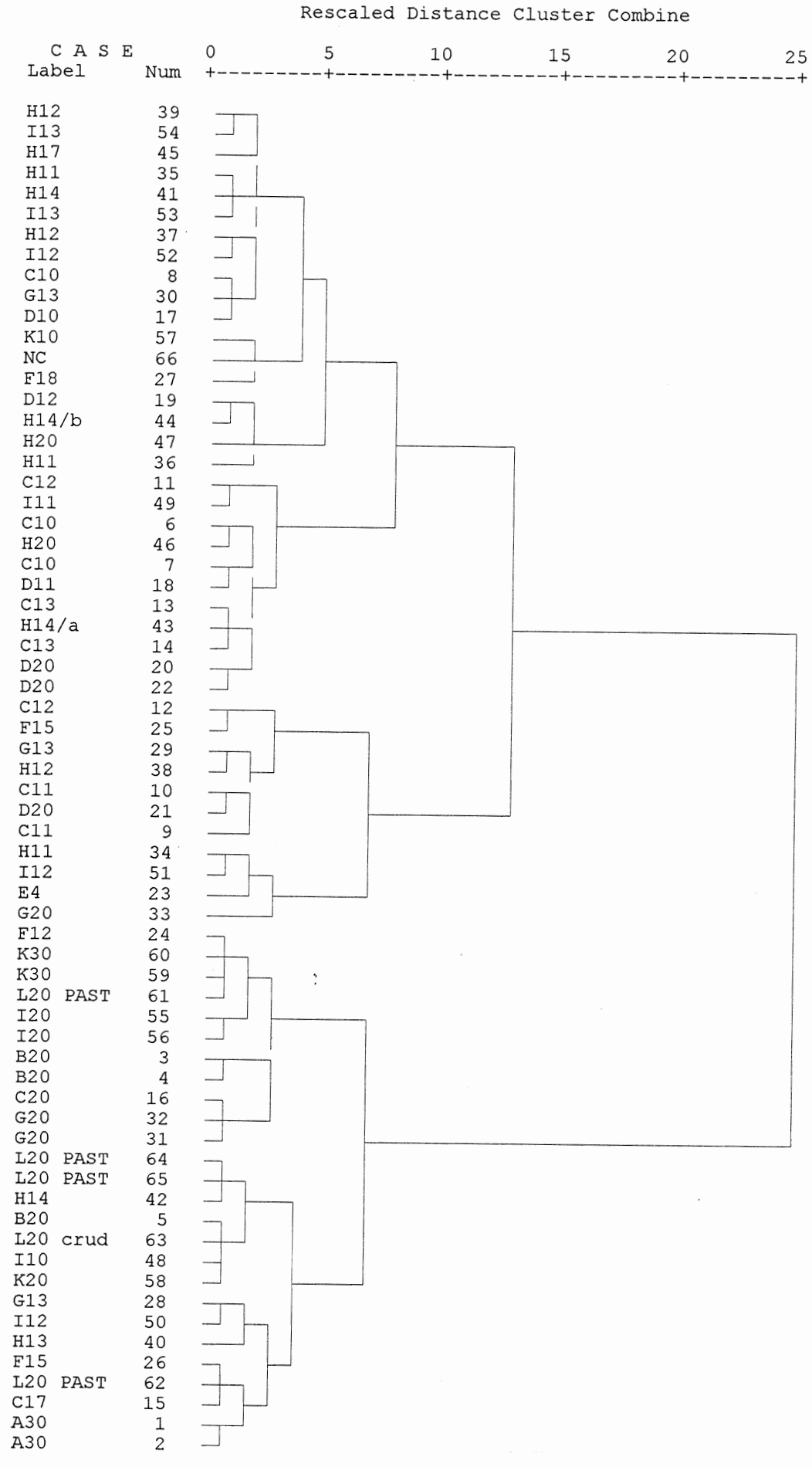

Figure 13: Dendogram of the producers of the *Toma Piemontese* and their label

* * * * * * H I E R A R C H I C A L C L U S T E R A N A L Y S I S * * * * * *

Dendrogram using Ward Method

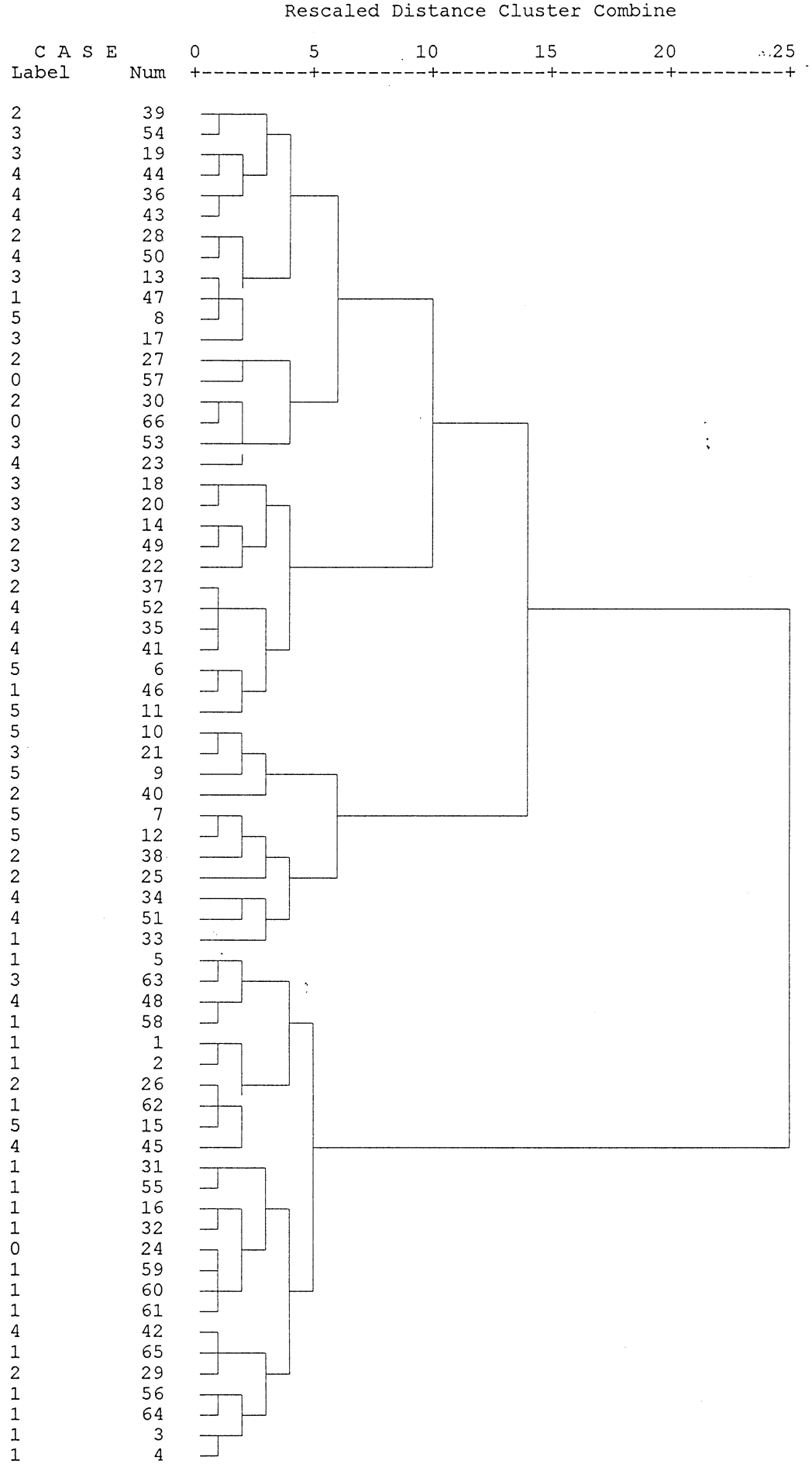

Figure 14: Dendogram of the categories and number of the samples.

Cluster A distinguishes oneself, because of the high quantity of producers grouped in category 1 (dairy industry). Cluster B and C contain approximately an equal quantity of the other categories. Though it is possible that producers of category one can be found in cluster B or C and the contrary producers of the other categories can be found in cluster A.
The principal distinction of the samples categorised in cluster A has been the use of a starter. A producer (F12), which has been grouped in an other category, has used a starter and have also been grouped in cluster A.
Some exceptions can be made for example number 33 producer G20 (categorised in the dairy industry), this sample has been grouped in cluster B. At the time of the sensory test this sample doesn't seemed to have a maturation of thirty days, it seemed much more rippend.

As appendix 2 shows there have been more producers of a dairy industry than the other four categories, tough this have no effect on the distinction of cluster A.
Figure 15 and 16 can confirm this. When cluster A is taken away of the cluster analysis, the results have been equal. Categories 2 till 5 show no distinction among each other.

The results of the dendogram have been associated with a spider-web diagram.
In a spider-web diagram the distance from the centre of the profile to the boundary line connecting each one of the attributes is in proportion to the means (*Powers, 1988*).
The first spider-web diagram (Fig. 17) refers to the quantitative description of aroma, structure and taste. The preference of group A have been high, which is in accordance with the low values of *Ammoniaca, Lipolisi* and *Proteolisi.*
The values of cluster C have been in the middle of cluster A and B, the preference of the panelists have also been high. Cluster B refered to cheeses with a little defect, because of the high values of lipolyse, acid and proteolyse.
The second spider-web diagram (Fig. 18) refers to the quantitative description of the aspects of pulp and eyes of the *Toma Piemontese*. The results of this diagram showed in cluster A a good colour uniformity of the pulp. Group B showed a high value of the thickness of the outer layer. Also in this diagram cluster C have been ranked in the middle.

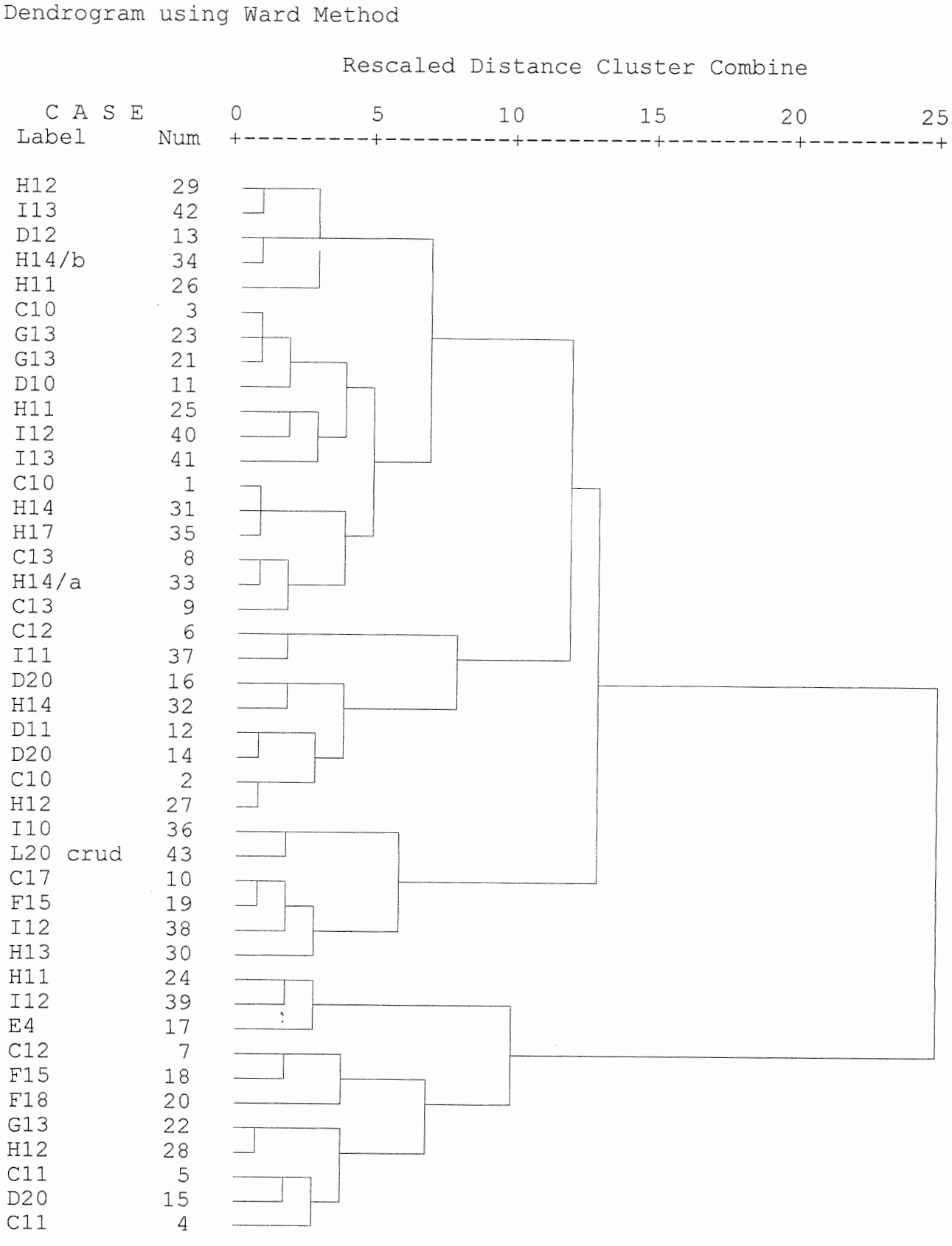

Figure 15: Dendogram without producers of category 1, with label of the producers.

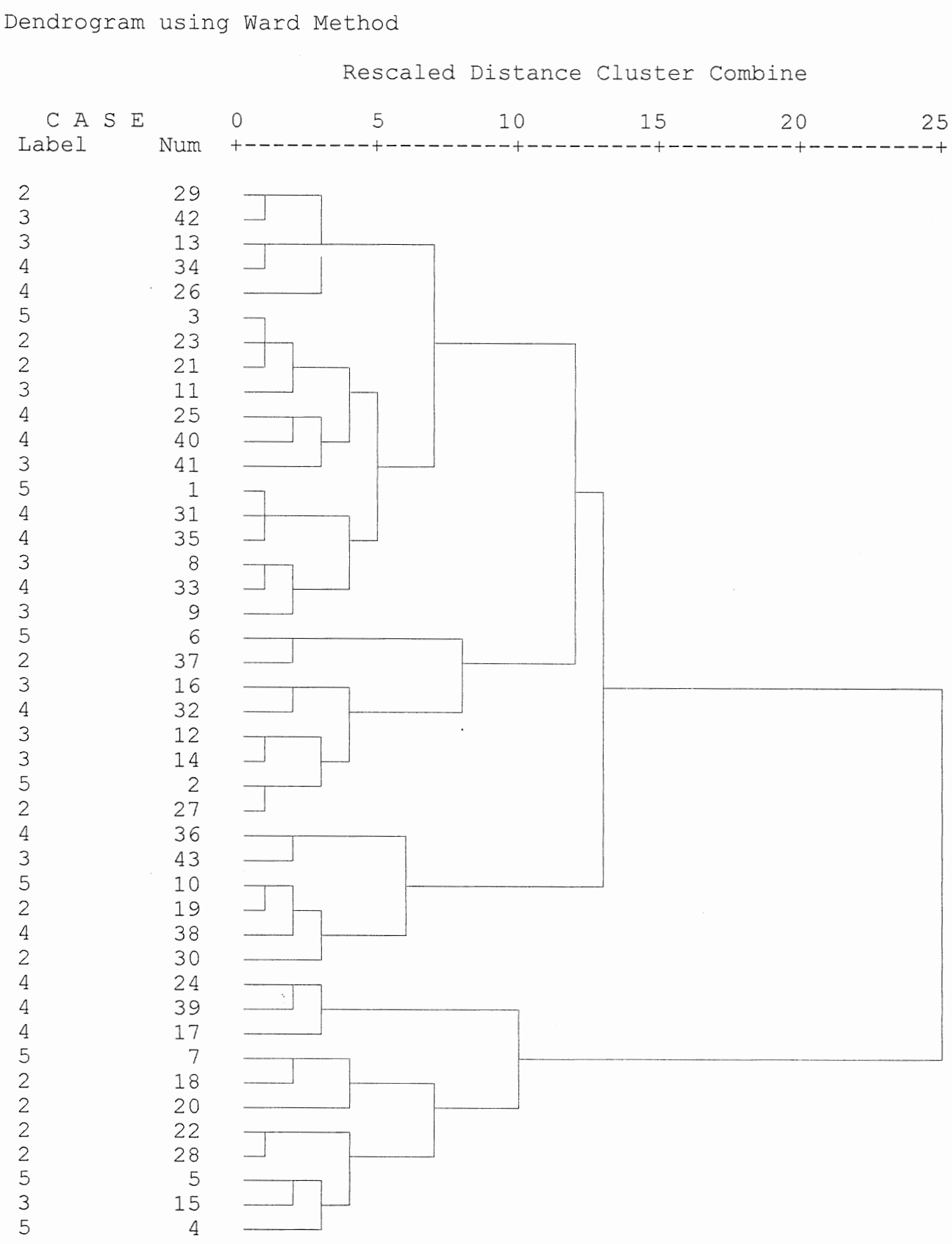

Figure 16: Dendogram without producers of category 1, with number of the samples and category

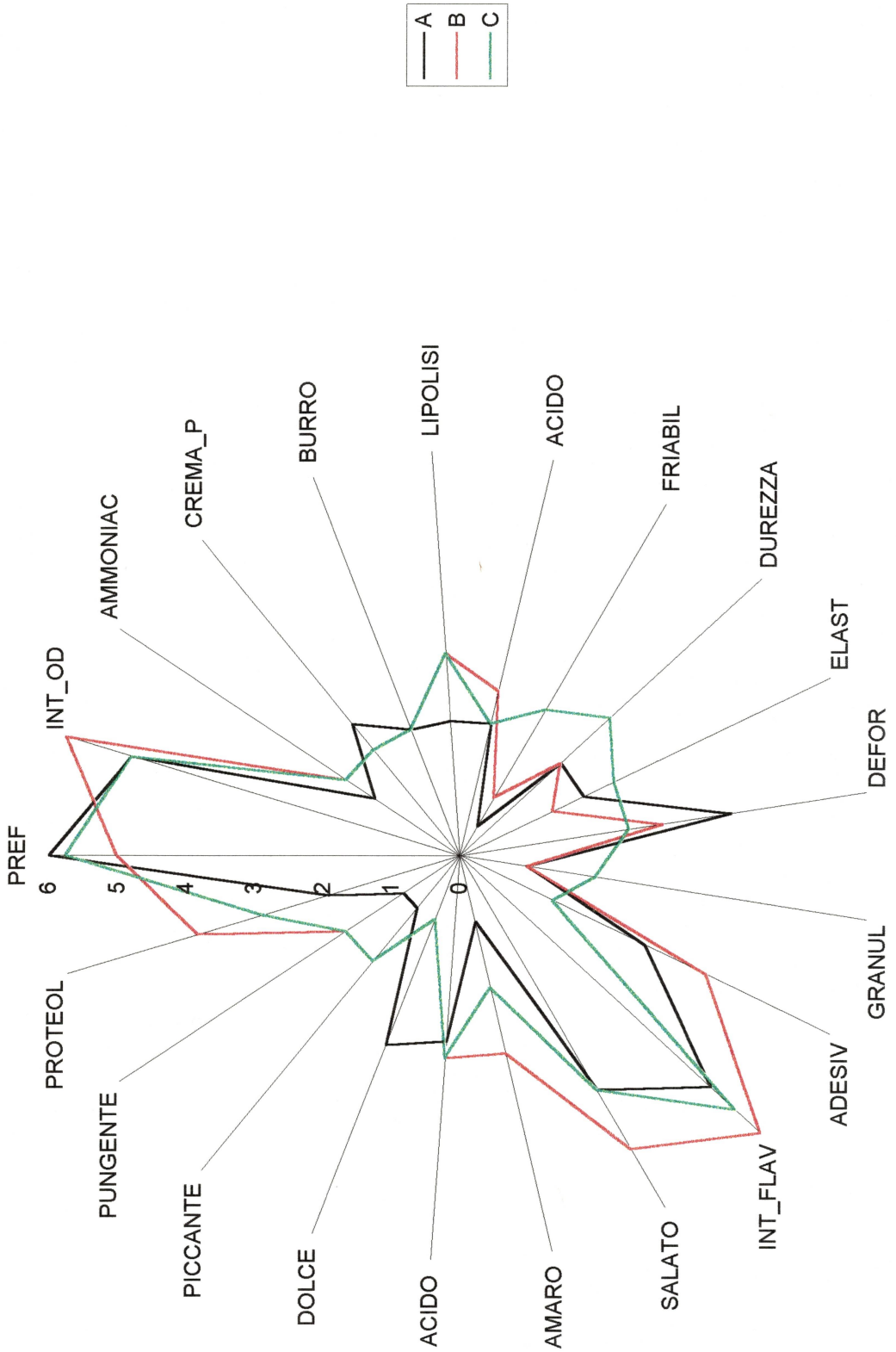

Figure 17: Spider-web diagram of the quantitative description of aroma, texture and taste.

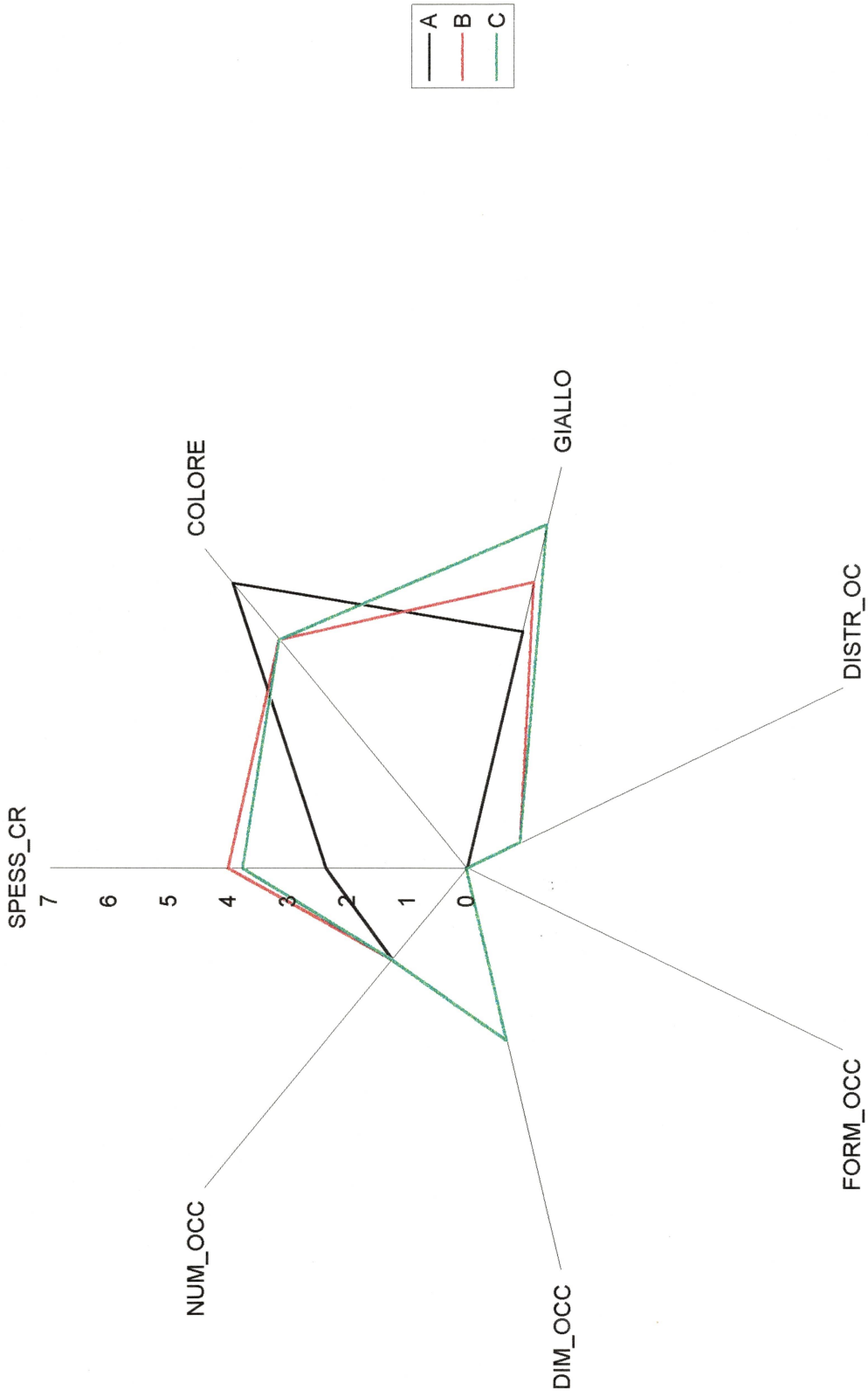

Figure 18: Spider-web diagram of the quantitative description of the aspects of colour and eyes of the *Toma Piemontese.*

The results of the all chemical and microbiological analysis have been performed in appendix 3 and 4. With the help of these results the average of the 66 samples have been calculated (Table 2).

Table 2: The average values of the 66 samples of *Toma Piemontese*

Variable	Mean	S.E. Mean	Std Dev.	Minimum	Maximum	Valid N
Fat content(%)	22.88	0.70	5.65	9.17	35.28	66
Fat (% ds)	43.13	1.04	8.43	19.81	54.62	66
Proteine (%)	25.24	0.37	2.99	19.83	35.97	66
Proteine (% ds)	48.40	0.91	7.40	36.51	71.94	66
Total nitrogen (% ds)	7.59	0.14	1.16	5.72	11.28	66
Soluble nitrogen (%)	1.12	0.06	0.51	0.32	3.85	66
Soluble nitrogen (% ds)	2.15	0.11	0.93	0.58	6.41	66
Maturation rapport (%)	28.65	1.58	12.84	8.86	89.26	66
Dry substance (%)	52.55	0.53	4.32	43.84	65.87	66
NaCl (%)	1.15	0.09	0.73	0.06	3.74	63
D-lactic acid (g/100)	0.49	0.03	0.24	0.02	1.04	66
L-lactic acid (g/100)	0.75	0.03	0.27	0.19	1.54	66
Lactic acid (g/100)	1.24	0.05	0.42	0.36	2.25	66
pH	5.28	0.03	0.24	4.82	6.00	65
Acidity (meq).	0.12	0.00	0.04	0.00	0.20	63
Total coliforms (/g)	73424.28	29104.24	236444.0	1.30	1500000	66
E. coli (/g)	3301.08	2116.46	17063.43	3.00	120000	65
Staph. aureus (/g)	11524.24	5576.05	45300.01	100.00	300000	66
Lactobacillus sp. (/g)	234210606	49945546	4.06E+08	100000	2.00+E09	66
Streptococcus sp. (/g)	485281515	90613216	7.36E+08	480000	3.70+E09	66

The average results of the samples grouped in cluster A, B or C have been processed in table 3. Afterwards the results of table 3 will be compared with the results of table 2, to see which cluster comes close to the average values of the 66 samples.

Table 3: The average values of microbiological and chemical analysis for clusters A, B and C.

	Cluster A	Cluster B	Cluster C
Fat content(%)	25.10	22.56	21.00
Fat (% ds)	47.42	42.31	39.60
Proteine (%)	23.50	25.61	26.67
Proteine (% ds)	44.87	48.38	51.57
Total nitrogen (% ds)	7.03	7.58	8.08
Soluble nitrogen (%)	1.09	1.35	1.07
Soluble nitrogen (% ds)	2.09	2.50	2.08
Maturation rapport (%)	29.77	33.63	25.74
Dry substance (%)	52.64	53.10	52.25
NaCl (%)	1.04	1.31	1.18
D-lactic acid (g/100)	0.37	0.57	0.58
L-lactic acid (g/100)	0.66	0.75	0.82
Lactic acid (g/100)	1.03	1.32	1.40
pH	5.26	5.36	5.27
Acidity (meq).	0.11	0.13	0.11
Total coliforms (/g)	16637.03	38296.36	137661.4
E. coli (/g)	215.68	6514.18	4742.138
Staph. aureus (/g)	5388.46	181.82	21327.59
Lactobacillus sp. (/g)	1.93E+08	1.94E+08	2.86E+08
Streptococcus sp. (/g)	6.12E+08	2.77E+08	4.5E+08

The dark coloured cels refer to a deviation of that value. For example a high fat content of the samples of cluster A. This value is in agreement with the results of the sensory test, because of a high value *of Crema_panna, Burro* and *Deformabilità* which is shown in the spider-web diagram of figure 17. Another high value have been the *Streptococcus sp.* in contrary with cluster B and C, this can be attributed to the use of a starter.

Cluster B shows high values for maturation, dry substance, NaCl, pH and acidity. The value of salt is in agreement with the valutation of the panelists. According to the spider-web diagram of aroma, texture and taste (Fig.17) the flavour of the samples categorised in cluster B have a high salt content.
The dry substance of cluster B has also got a higher value than cluster A and C. This can be described to the value of the maturation rapport (the division of total nitrogen and soluble nitrogen multiplied with 100%). In comparison with cluster A and C the samples grouped in cluster B have had a characterisation of longer rippend cheeses.

Cluster C show a high value of total coliforms, which possible affect the taste of the samples, however this effect had not been of great influence on the preferation of the panelists.
Most average values of cluster C have been between the values of cluster A and cluster B.

In comparison with the clusters the average values of the 66 samples comes close to the average results of cluster B. The panelist prefered first cheeses grouped in cluster A, then C and at last B. This confirm that there has not been a correlation between the results of the microbiological and chemical analysis and the sensory tests.

CONCLUSION

The sensory characteristics of the *Toma Piemontese* have not been dependend on technical parameters, microbiological and chemical analysis, nor the production methods have been decisive, but it is the interaction of these factors and the production of the producer that can cause a high preference of a *Toma* cheese.

The preference of the panelists goes to the cheeses categorised in cluster A, which distinguishes onself by the use of a starter. This can be confirmed by producer F12, which also makes use of a starter.
The preference for the cheeses of cluster B is low, becauses these cheeses show a little defect caused by the proces proteolyse and lipolyse, which give a strange smell and taste to the cheese.
The preference for the samples of cluster C have been in the middle of clusters A and B.

With the help of the average of the microbiological and chemical results for the samples grouped in cluster A, B or C a comparison could be made with the results of the sensory tests.
Cluster B had a high valutation of salt at the sensory tests. This result can be confirmed by the chemical test for the content of NaCl.
The panelists estimated a high percentage of <<*Crema_panna, Burro* and *Deformabilit* >> of the cheeses grouped in cluster A. The chemical analysis of this value point out the same.

In the contrary the comparison with the average results of clusters A, B and C and the average of the 66 samples approach most of the time the resulsts of cluster B. Cluster B has been estimated by the panelists as the cheeses with the lowest preference.

That means that the greater part of the microbiological and chemical results cannot be correlated with the results of the sensory tests.

It does not matter if the *Toma Piemontese* is produced in the province of Turin or Biella, a good *Toma* cheese can be produced on condition that the producers work properly.

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APPENDIX

APPENDIX 1 **Sensory attributes used to describe the descriptors of the *Toma Piemontese* and their meanings in English.**

ITALIAN	ENGLISH
SENSAZIONE OLFATTIVA	OLFACTORY SENSATION
Intensit odore	Total intensity of aroma
Ammoniaca	Ammonia
Crema, panna	Milky-creamy
Burro	Buttery
Lipolisi	Lipolysis
Acido	Acid
TESSITURA	TEXTURE
Friabilit	Fracturability
Durezza	Hardness
Elasticit	Springiness (elasticity)
Deformabilit	Cohensiveness
Granulosit	Number of grain
Adesivit	Adhesiveness
GUSTO	TASTE
Intensit del flavor	Total flavor intensity
Salato	Salty
Amaro	Bitter
Dolce	Sweet
Piccante	Hot
Pungente	Pungency
Proteolisi	Proteolysis
Spessore crosta	Thickness of outer layer
Uniformit colore pasta	Colour uniformity of pulp
Intensit del giallo	Colour intensity of pulp
Distribuzione regolare degli occhi	Regular distribution of the eyes (holes)
Forma regolare degli occhi	Regular form of the eyes
Dimensione degli occhi (mm)	Dimension of the eyes (mm)
Numero di occhi (su 10*5 cm)	Number of eyes (on 10*5 cm)

APPENDIX 2 **Producers of the Toma Piemontese with their label and category**

Label	Category	Producer	
A30	1	Caseificio PAL S.r.l.	A = Novara
B20	1	Morino	
C10	5	Clerico	B = Vercelli
C11	5	Giacomone	
C12	0	Agriturusmo di Prina Cerai Aldo	C = Biellese
C13	3	Rosso Bajetto	
C17	5	Bersano	D = Alto Canavese
C20	1	Caseificio "Alta Valsesia" Soc. Coop.	
D10	3	Bracco Luigi	E = Val Pellice
D11	3	Gallo Marisa	
D12	0	Neretti Luciano	F = Valli di Lanzo
D20	1	Mombarone	
E4	4	Durant Canton Franco	G = Val di Susa
F12	0	Dardino	
F15	2	Garbolino Catarina	H = Valli Chisone, Sangone, Orco
F18	2	Ruo Rui Silvia	
G13	2	Pedussia	
G20	1	Bruzolese	I =Torino
H11	2	Lussiana	
H12	2	Rege Mario e Angelo	K = Cuneo
H13	2	Gioviale Luciano	
H14	4	Versino	L = Cuneo bassa Montagna
H17	1	Azienda Agricola Valleorco Frola Guiseppina	
H20	1	Latteria sociale Valle Sacra	NC = non classificato
I10	4	Perotto	
I11	3	Bagnod Roberto	
I12	2	Berton	
I13	3	Calza Cita Guiseppe	
I20	1	Caseificio Malandra	
K10	0	Mte Robiglio	
K20	1	Ceirano	
K30	1	Quaglia	
L20	1	Valle Josina	
NC	0	Bruno	

APPENDIX 3: Results of the microbiological and chemical analysis

Label	Cluster	Category	Fat (%)	Fat (% ds)	Proteins (%)	Proteins (% ds)	Total nitrogen (%)	Soluble nitrogen (%)	Soluble nitrogen (% ds)	Maturation rapport	Dry substance (%)	NaCl (%)	D-lactic acid (%)	L-lactic acid (%)	Lactic acid (%)	pH	Acidity (meq)	Total coliforms (CFU/g)	E. coli (CFU/g)	Staph. aureus (CFU/g)	Lactobacillus sp. (CFU/g)	Streptococcus sp. (CFU/g
H11	C	4	19.1	36.54	29.17	55.81	8.75	1.46	2.79	31.93	52.27	1.10	0.85	0.89	1.74	5.57	0.11	2200	2000	100	4.5E+07	1.5E+07
H12	C	2	24.29	50.47	23.66	49.16	7.71	1.79	3.72	48.27	48.13	2.70	0.80	1.12	1.92	5.37	0.17	700	10	100	5.4E+08	2.6E+08
H14/a	C	4	14.03	28.34	26.65	53.84	8.44	1.17	2.36	27.94	49.50	2.15	0.66	0.71	1.37	5.61	0.12	3000	10	100	5800000	1.5E+08
H14/b	C	4	18.59	36.32	27.64	53.99	8.46	1.15	2.25	26.54	51.19	1.38	0.25	1.21	1.45	5.05	0.15	57000	300	100	600000	7E+07
I13	C	3	20.37	38.75	22.76	43.29	6.79	0.70	1.33	19.62	52.57	0.86	0.21	1.54	1.75	5.01	0.13	50	40	100	1E+07	8E+07
C10	C	5	24.63	46.45	23.6	44.51	6.98	1.08	2.04	29.20	53.02	1.97	0.56	0.54	1.09	5.32	0.11	4700	400	100	8.2E+07	1.5E+08
C11	B	5	28.97	51.41	22.91	40.66	6.37	1.37	2.43	38.15	56.35	1.55	0.20	0.80	1.00	5.50	0.14	2400	800	100	2E+08	3.5E+08
C12	C	5	24.01	45.80	23.81	45.42	7.12	1.94	3.70	51.98	52.42	2.73	0.17	0.19	0.36	5.52	0.12	2700	400	100	5400000	1.1E+07
C13	C	3	12.85	27.93	27.74	60.30	9.45	1.07	2.33	24.61	46.00	1.21	0.69	0.75	1.44	5.39	0.09	400	80	100	2E+07	1.9E+07
I12	C	4	26.28	47.53	24.3	43.95	6.89	1.60	2.89	42.01	55.29	0.70	0.82	0.84	1.65	5.22	0.20	540	500	100	1.4E+07	5.4E+07
L20 past	A	1	30.22	51.95	21.24	36.51	5.72	0.88	1.51	26.43	58.17	1.34	0.61	0.80	1.41	4.92	0.15	150	10	1500	1.3E+07	3E+08
C20	A	1	26.54	50.39	21.49	40.80	6.40	0.81	1.54	24.05	52.67	0.64	0.22	0.37	0.59	5.90	0.14	10	10	100	3000000	4E+07
G13	C	2	22.73	44.34	22.29	43.48	6.82	1.10	2.15	31.48	51.26	1.89	0.44	0.58	1.02	5.41	0.17	50000	10	100	600000	1600000
D11	C	3	10.48	23.91	27.5	62.73	9.83	1.20	2.74	27.84	43.84	0.58	0.51	0.76	1.27	5.67	0.13	4000	10	100	9E+07	7E+07
D12	C	3	24.01	47.19	23.19	45.58	7.14	0.66	1.30	18.16	50.88	1.76	0.63	0.70	1.33	4.97	0.17	22000	10	100	1.1E+08	1.9E+08
D20	C	3	16.28	30.04	29.39	54.23	8.50	0.67	1.24	14.54	54.20	nd	0.61	0.78	1.39	5.40	0.08	150000	10	1000	2.3E+08	2.1E+08
F15	B	2	18.71	36.61	27.77	54.34	8.52	0.70	1.37	16.08	51.10	0.87	0.51	1.10	1.61	5.39	0.10	24000	10	100	3.3E+07	3E+07
G20	A	1	29.74	53.91	23.03	41.74	6.54	0.32	0.58	8.86	55.17	0.91	0.71	0.82	1.53	5.14	0.11	10	nd	100	9E+07	2.2E+09
A30	A	1	23.3	48.65	19.83	41.41	6.49	0.59	1.22	18.82	47.89	1.12	0.17	0.43	0.60	5.18	0.12	1160	10	100	4000000	2.3E+07
B20	A	1	16.89	35.80	26.6	56.38	8.84	1.87	3.96	44.85	47.18	2.46	0.33	0.39	0.72	5.58	0.14	370	30	100	2.1E+07	1.1E+08
D10	C	3	15.15	31.73	28.69	60.08	9.42	0.86	1.80	19.12	47.75	nd	0.49	1.17	1.66	4.96	0.16	33000	500	100	9000000	3.5E+08
E4	C	4	20.75	36.69	26.8	47.38	7.43	0.86	1.51	20.35	56.56	3.74	0.93	1.13	2.06	5.18	0.19	10	10	100	1.4E+07	5.6E+07
H20	C	1	21.93	41.79	25.93	49.41	7.74	0.83	1.59	20.52	52.48	1.03	0.80	0.81	1.61	nd	0.17	20	10	100	800000	900000
I20	A	1	27.55	51.36	25.31	47.18	7.40	0.80	1.50	20.24	53.64	0.35	0.22	0.45	0.67	5.33	0.11	130	20	100	100000	480000
K30	A	1	26.89	49.30	25.09	46.00	7.21	2.30	4.22	58.49	54.54	0.23	0.43	0.46	0.89	5.37	0.16	90	90	100	2.7E+07	1.1E+08
F15	A	2	19.18	41.69	22.11	48.05	7.53	1.25	2.71	36.04	46.01	1.26	0.42	0.46	0.87	5.50	0.08	8000	300	100	3.8E+07	1.7E+07
G13	C	2	23.32	46.84	22.12	44.43	6.96	0.91	1.83	26.33	49.79	0.11	0.53	1.03	1.56	5.06	0.15	48000	10	100	2.9E+07	9E+07
G20	A	1	27.92	52.15	22.19	41.45	6.50	1.87	3.49	53.65	53.54	1.03	0.34	0.37	0.70	5.53	0.07	8600	10	400	4E+08	5.4E+08
H11	B	4	17.04	34.35	28	56.44	8.85	1.04	2.10	23.79	49.61	0.55	0.78	0.83	1.61	5.25	0.12	150	10	100	1.1E+08	5E+07
H12	C	2	18.08	37.14	25.81	53.02	8.31	1.09	2.23	26.84	48.68	0.41	0.87	0.90	1.77	5.32	0.10	1700	10	100	3.7E+08	2.3E+08
H13	B	2	25.04	48.50	24.33	47.12	7.39	1.20	2.33	31.49	51.63	0.06	0.24	0.26	0.50	5.53	0.11	1.3	10	5000	3.1E+08	1.7E+08
H14	C	4	17.97	34.01	25.54	48.34	7.58	1.02	1.94	25.55	52.83	0.91	0.70	0.80	1.49	5.20	0.00	600	10	100	1.2E+08	1.9E+08
I12	B	4	18.96	40.98	22.9	49.49	7.76	0.83	1.80	23.15	46.27	nd	0.86	1.03	1.90	5.04	0.13	1.4	60	100	1.2E+09	7.1E+08
I20	A	1	29.96	54.62	22.54	41.09	6.44	1.98	3.61	56.04	54.85	0.97	0.02	0.57	0.58	5.33	0.09	10	10	100	2200000	2.2E+08
L20 past	A	1	28.36	51.38	21.7	39.31	6.16	0.95	1.72	27.87	55.20	0.16	0.06	0.82	0.89	5.24	0.10	150	10	100	1.2E+08	9.2E+08
C10	C	5	28.94	52.88	24.13	44.09	6.91	0.97	1.78	25.73	54.73	0.86	0.61	0.81	1.42	5.24	0.10	7800	2000	100	3E+08	3.4E+08
C12	C	5	22.24	42.47	26.98	51.52	8.07	1.27	2.43	30.08	52.37	2.14	0.53	0.25	0.78	5.26	nd	210000	70000	100	8.7E+08	1.3E+09
H17	A	4	26.84	50.48	22.21	41.77	6.55	0.85	1.59	24.33	53.17	0.76	0.55	0.59	1.14	5.14	0.09	700000	120000	100	6.6E+08	8.2E+08
I11	C	2	26.46	44.07	28.82	48.00	7.52	1.18	1.96	26.03	60.04	0.64	0.45	0.46	0.91	5.52	0.08	2140	90	100	2.3E+07	4.2E+07
I13	C	3	24.73	44.30	28.08	50.30	7.88	0.83	1.48	18.77	55.82	0.58	0.56	1.09	1.65	5.00	0.12	2800	2600	100	1.2E+08	1.3E+08
A30	A	1	25.6	50.04	20.73	40.52	6.35	1.55	3.03	47.67	51.16	0.23	0.27	0.42	0.69	4.98	0.11	10	10	100	1200000	600000
B20	A	1	17.75	35.44	27.83	55.57	8.71	1.27	2.54	29.14	50.08	0.97	0.43	0.55	0.98	5.23	nd	30	10	100	1200000	500000
D20	B	3	18.03	36.83	27.07	55.30	8.67	1.70	3.46	39.95	48.95	0.17	0.51	0.54	1.06	5.80	0.10	16000	4000	16000	2.3E+08	1.7E+08
H20	C	1	28.96	48.85	25.57	43.13	6.76	1.21	2.04	30.24	59.28	0.06	0.64	0.65	1.30	5.17	0.11	300	40	100	9000000	1600000
B20	A	1	26.72	51.20	22.92	43.92	6.88	1.01	1.94	28.11	52.19	1.74	0.27	0.62	0.89	5.10	0.08	580	460	100	5.8E+08	7.6E+08
C11	B	5	27.16	49.31	25.75	46.75	7.33	0.91	1.65	22.57	55.08	1.16	0.26	0.79	1.04	5.32	0.09	450	3	100	2.3E+08	6.7E+08
D20	C	3	12.87	25.26	35.97	70.58	11.06	1.02	1.99	18.02	50.96	1.40	0.50	0.79	1.30	5.41	0.06	540000	1100	100	4E+08	1.9E+09
G20	B	1	28.83	47.95	27.54	45.80	7.18	3.85	6.41	89.26	60.13	1.45	0.33	0.41	0.74	6.00	nd	10	3	100	2.4E+07	2.3E+07
H11	C	4	18.35	35.48	28.88	55.84	8.75	1.06	2.06	23.48	51.72	1.45	0.58	0.66	1.24	5.42	0.06	1500000	120	100	5.3E+08	8.8E+08
H12	C	2	16.41	33.68	27.93	57.32	8.98	1.38	2.83	31.45	48.73	2.05	0.58	0.61	1.19	5.55	0.05	900000	1100	100	9.3E+07	9.7E+08
C10	C	5	23.71	46.19	23.82	46.41	7.27	0.72	1.40	19.20	51.33	0.53	0.36	0.78	1.14	5.25	0.08	150000	1100	150000	6.6E+08	6.4E+08
C13	C	3	9.171	19.81	33.31	71.94	11.28	1.06	2.29	20.34	46.30	1.41	0.30	0.55	0.86	5.49	0.06	160	3	100	2E+07	4900000
C17	A	5	25	48.79	23.35	45.57	7.14	0.76	1.48	20.74	51.24	1.02	0.22	0.88	1.10	5.24	0.05	150000	1100	100	5.4E+08	5.6E+08
F12	A	0	18.98	38.73	25.34	51.71	8.11	1.17	2.38	29.38	49.00	0.80	0.11	0.86	0.97	5.26	0.09	10	3	100	8000000	2.8E+09
I10	A	4	20.25	44.11	20.15	43.89	6.88	0.79	1.72	24.98	45.91	0.73	0.33	0.82	1.15	5.13	0.12	150000	1100	2300	7.8E+07	1.1E+09
L20 raw	A	3	27.2	50.35	22.22	41.13	6.45	0.96	1.78	27.62	54.02	0.84	0.52	0.75	1.27	5.24	0.10	43000	1100	19000	1.2E+08	2.1E+09
L20 past	C	1	31.44	50.66	25.83	41.62	6.52	1.18	1.90	29.12	62.06	0.99	0.46	0.77	1.23	5.23	0.12	10	3	100	1.4E+08	8E+08
F18	B	2	14.258	31.09	27.36	59.66	9.35	1.28	2.78	29.73	45.86	0.86	0.54	0.81	1.35	5.21	0.12	37000	3	100	4.6E+07	3.3E+07
G13	C	2	25.26	47.50	26.91	50.60	7.93	0.81	1.51	19.09	53.18	1.32	0.68	1.37	2.05	4.95	0.16	2000	23	300000	2E+09	1.8E+09
H14	C	4	21.68	42.80	25.98	51.29	8.04	0.72	1.43	17.73	50.65	1.76	0.83	0.49	1.32	5.28	0.11	4000	1100	70000	4E+07	3.7E+07
I12	C	4	21.14	38.52	26.63	48.52	7.61	0.62	1.12	14.76	54.88	1.38	0.61	0.76	1.36	5.00	0.11	3000	1100	150000	2E+09	3.7E+09
K10	B	0	31.24	50.66	24.13	39.13	6.13	0.77	1.25	20.44	61.67	0.18	1.04	1.21	2.25	4.82	0.20	10	3	100	9E+07	3.2E+07
K20	A	1	30.31	52.92	22.08	38.55	6.04	1.01	1.76	29.07	57.27	1.17	0.60	0.74	1.34	4.96	0.17	60	3	100	1E+09	8.1E+08
K30	A	1	25.77	47.01	25.41	46.35	7.27	1.03	1.87	25.74	54.82	1.45	0.15	0.92	1.07	5.11	0.11	170	210	40000	1E+07	1.3E+07
L20 past	A	1	29.1	51.03	22.92	40.19	6.30	0.83	1.46	23.19	57.03	2.32	0.20	1.00	1.20	5.03	0.12	10	3	100	3E+08	1.5E+09
NC	C	0	35.28	53.56	26.66	40.47	6.34	0.57	0.87	13.74	65.87	1.10	0.89	0.94	1.83	5.06	0.15	600	460	100	8E+07	8.7E+07

nd = not determined