



THESIS

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THESIS:

DEVELOPMENT, PRODUCTION AND INTRODUCTION OF RED FLESH APPLES ON THE MARKET

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Preface and acknowledgements

This thesis is the final work of my European Engineer Degree at the AERES University of Applied Sciences in Dronten, the Netherlands. This serves as documentation of my research during the study, which has been made from September 2018 until January 2019. It presents the results of a study concerning future apple varieties and especially the red flesh apples. The topics of apple production and new varieties were chosen following my interest for these disciplines as this is part of my career expectation. This subject came up during my placement period at Rivoira in Italy, a company specialised in production, packaging and fruits export.

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Summary

Nowadays, in Europe, there is a declining consumption of apples. Many reasons could explain this trend such as the decreasing percentage of the budget given to fresh fruits per household. The whole sector is involved to find a solution to reverse this negative trend.

An answer to this problem could be the introduction of a new variety on the market. This variety is a new kind of apple. It is a red flesh apple, which means that the fruit is red outside and red inside. Still under investigation, the work along this thesis was to determine the impact and the future of these new varieties.

The target group for this research was the apple industry. The whole sector is involved, from the researcher, the nursery, the growers, the wholesalers, the supermarket till the consumer. In this way, the final objective of this research was to propose solutions and guidelines for companies which consider to grow red flesh apples.

The chosen way was qualitative methods through interviews. The work was divided in four points.

The first point was concerning the research and the breeding of these fruits. Researchers and breeders from different companies were interviewed to understand the breeding program. Three main varieties were studied and summarized in a table: Red Moon, Red Love and Kissabel.

Then, the agronomic aspects of red flesh apples were studied to compare the differences between an orchard of red flesh apples with a classic orchard. Many essential points were studied such as density of plantation, thinning, production area, in order to give the best recommendations as possible to the growers.

After, the health and nutritional values were examined in order to consider the nutritional differences between red flesh and classic apples. Here, results showed that red flesh apples have higher nutritional values than the classic apples. A table was done to compare classic white flesh and red flesh varieties.

Finally, the sales and marketing strategy was investigated through interviews with purchasers from large retailers and short surveys with final consumers in supermarkets. As they do not have the same considerations, two different surveys were done and adapted to each target: purchasers and consumers. This provided clear results from both sides. Purchasers are looking for new varieties to improve the attractiveness of their shops and consumers would like to try these new apples.

Subsequently some guidelines were given to these companies how to gain market share through these fruits. For the growers, the selection of a right production area is very important to have a nice quality of fruits (red inside and outside). Then, the number of fruits per plant should be around hundred apples.

Regarding sales and marketing strategy, the first objective will be to differentiate the red flesh apples from the other red apples. In order to answer this question, many solutions exist. Organisation of tasting in the supermarket with consumers to promote these new apples, advertisement through poster, social medias, newspapers, radio. The target group of this advertisement will be the new generation of consumers. The principal argument should be about the better nutritional values of the red flesh varieties.

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I. Introduction

Context:

At the beginning, the apple grew in the wild, from South Caucasus to West part of China. Romans participated in the introduction and development of this fruit in Europe along their conquests on the continent (Janick, 2005). Centuries later, Italy has become an essential key player in the production of this fruit in Europe.

According to 2017 figures, apples remain the most produced fruit in Europe, with 9 343 000 tons harvested (Raynal, 2016). The production is divided between three important countries, Poland 2 870 000 tons, Italy 1 757 000 tons and France 1 396 000 tons (WAPA, 2018). The European expectation for the harvest 2018 is good, 12 610 000 tons being +25.9% compared to 2017. However, this increase is the consequence of a smaller harvest in 2017, after frost damage (Collen, 2018). The most produced varieties in Europe are Golden, Gala, Idared, Jonagold and Red Delicious. (WAPA, 2018)

When consumers buy apples in the supermarket, they want a good taste. This is a task of the growers to satisfy this demand. The selection of the best cultivar is a key point to achieve this goal.

In order to increase the European apple consumption, growers and nurseries are focused on developing new varieties, to bring something new on the market. After the Second World War, farmers started to produce Golden, which was a productive variety with a long shelf life in cold storage. Then, during the 1990's growers started to plant bicolour apples (FNPF, 2006). These fruits were very attractive for the consumer in the supermarket. At the beginning of 2000's, one apple variety has revolutionised the market organisation: Pink Lady, the first "club-variety" (Lacan, 2015). Since that time, many apples appeared on the market on the same system as Pink Lady Club. (Mertz, 2017)

Club varieties are protected brands that means only the members are authorised to carry out the production of the plants, the production and the sale of these fruits. Fruits must meet specifications and there should be no difference in appearance, taste and colour, regarding the origin of the production. To promote its fruits, each brand is represented by an association of producers, nurseries and marketers, who gathers resources in order to finance commercial and marketing actions. (AGIR, 2014)

To illustrate how these club varieties work, let's take the example of the most famous Apple Club: The Pink Lady. Pink Lady Europe association brings together nurseries, producers and marketers. The association controls plantation area to regulate the fruit production on the market. The fruits must meet strict specifications such as colour, size, sugar level to be sale under Pink Lady brand. And finally, these fruits can be sold only by approved packhouse called "marketer". Since its arrival on the market in 2000, it is an innovative approach in the fruit and vegetable sector. Kanzi apple is based on the same concept than Pink Lady and it is success variety in Europe

Nowadays, there is a big range of different apples in supermarkets; often consumer get lost in all these different varieties (Lehnert, 2015). According to Fresh Plaza, apple consumption in Europe is declining. The downward trend is about 2% per year (Global apple consumption grows, 2015). On the other hand, the consumption of process apples like juice and applesauce show a strong growth on the global market, the positive trend is about 4.5 % per year (Today industry, 2017).

According to a report from European commission, the apples production is rising, as demand falls. Indeed, apple production is likely to increase in the future, particularly in Poland, while consumption of fresh apples per capita keeps on decreasing. (Comission, December 2016). The apple industry needs to find a solution to improve and dynamize the fresh fruit sector.

The topic of this study comes from a new type of fruit: an apples variety that's red outside and red inside called red flesh apple. Currently under development, red-flesh apples have the opportunity to renew the market and bring novelties on the latter.

The target group for this research is the apple industry. The whole sector is involved, from the researcher, the nursery, the growers, the wholesalers, the supermarket till the consumer. The plan is to focus on each step in the chain to have an overall overview.

Theoretical framework and knowledge gap:

The development of red flesh apples is done by different nurseries. Owing to the competition, companies do not communicate because of the important economic importance of these new varieties, which leads to confidentiality of the research. Indeed, few things are known about this topic and it is difficult to find information on internet. For this reason, the research was done through the qualitative method.

The research on this topic concerned the following key points:

- first the research and the breeding of these fruits,
- then the agronomic aspect of the red flesh apples,
- followed by the health and nutritional points and,
- finally, the sales and marketing strategy.

To find information, beside the literature review, the research process started with interviewing different key-persons active in this sector, thanks to three different surveys. The choice of three surveys was needed to adapt the question regarding the interviewee.

Objective of this thesis:

Still under investigation, the work along this thesis was to determine the impact and the future of these new varieties. Today, the consumption of apples is decreasing in Europe. This research will aim at answering the question if red-flesh apples have the potential to reverse the actual trend. In this way, the final objectives will be to propose solutions and guidelines for companies which plan to grow red flesh apples. The following objective for the companies is to gain some market share through theses fruits. The aim of this research is to answer the question bellow:

Questions:

Main research question:

Till what extend red-flesh apples can reverse the negative trend in European apple consumption and become the varieties of the future?

Sub-question 1: Research

How did researchers discover and further develop the red-flesh apples?

The aim of this sub-question was to understand how researchers found these varieties and how further research took place. Understand how they breed apples is essential. Then, the next step was to compare each different program to determine what were the pros and cons for each of them.

Sub-question 2: Agronomic

How to manage a red flesh apples orchard and what are the changes for the farmers compared to classic apples trees?

At the end of this research, the conclusion should explain and clarify the differences in management between a red and a white-flesh apple. Moreover, this should provide information and advice about the opportunities for producers of red-flesh apples. These advices are focus on plantation and the running life of the orchards as well. These recommendations are destined to the growers who are interested by the implantation and production of red flesh apples.

Sub-question 3: Health

Are there nutritional differences compared to classic apples and are red flesh apples healthier?

Because of their red colour inside, the composition of the flesh is different from a white flesh apple. Apples are healthy anyway, they are high in vitamins and antioxidants, and red flesh apples could be even healthier. The nutritional value and differences between these apples were studied and compared. In conclusion, will be explained if these new fruits are better or not for the health.

Sub-question 4: Sales

Is there a place in the consumer-market for these new apples?

Consumer-appreciation, expressed in sales-figures, is the key point for success of a new variety. Currently, there is a big amount of apple varieties in the supermarket, red (Gala and Red Delicious), yellow (Golden), green (Granny smith) and 'club varieties' such as Pink Lady or Kanzi. At present, hardly any red-flesh apples are available in the supermarket. Large retailers have to bring novelty their supermarkets to attract new consumers and increase the sales.

This study will try to find out if the consumer will be attracted to buy these new varieties. The attraction could be done with: outside appearance, the colour inside or by the taste.

II. Materials and methods

Qualitative method is required

In order to answer the main question, research was carried out following the different sub-questions, which has a specific methodology.

As explained previously, the research was done through the qualitative method, consisted in interviewing professionals of the different sectors involved. A structured interview with a survey should create an interaction between both persons. For this topic, the qualitative method presents many advantages to collect data. This method means few persons were interviewed but the answers provided relevant information: the opinion, the feeling and knowledge of a person. To success the interaction, the interviewer should be competent in interviewing. Interview schedule was required to organise the meeting.

There were three different types of survey: one questionnaire for the breeders and agronomists, a second for the purchaser of the large retailers and a third destined to the apple consumers. Three surveys were written to adapt the questions regarding the interviewee and collect data to answer the different topics of each sub-questions. Please find a copy of the three different survey in the appendices.

The place choice for the realisation of the interview was the Fruits Attraction in Madrid. This fair regroups all the sector of the fruits during three day, from 15th to 17th October. Many nursery, breeders, growers and sellers were present. In total, seven interviews were realized during the Fruit attraction. Three were done with the breeders of red flesh apples Red Love, Red Moon and Kissabel. This three group are private nursery where red flesh apple were developed. Then, in a second part three others interview were completed with purchasers specialized in fruits. The first company was Mouneyrac a wholesaler located in Rungis in France and the two others are purchasers from supermarket Mercadona in Spain and Intermarché in France. The last meeting was completed with the interview of an agronomist Alessandro Rizzato in charge of the experimental orchards of Rivoira company, which is one of the largest growers and exporter in Italy.

The last step was to realized quick interviews with the final consumers in different supermarket in Europe. Three countries were selected Italy, France and Netherlands to completed the last survey destined to the fruit consumers in Europe. For each country around twenty-five survey were realized.

The expectations of these different interviews were high, they help to collected much information. However, concerned people should agree to talk with the student, this was not an easiest thing. The collection of data was done with three main companies. These three breeders, IFORED (Kissabel is the commercial name of these fruits), Red Love and Red Moon, were the most advanced in red flesh apples. Fruit attraction was the great place to meet and interviewed different persons who played an essential role in red flesh apples programs.

Sub-question 1: Research

The first method used to answer this question was literature review, scientific articles were studied to explain the research. Two articles were found: extracted from a scientific review published in New-Zealand. Scientists explain their methods to breed a red flesh apple.

In a second part, an interview with Emmanuel De Lapparent the manager of IFORED Research Centre in Angers was planned. IFORED is a global consortium consisting of 14 fruit companies active in 13 different countries. They started the research twenty years ago, now the apple trees are under investigation. The range of apple developed by IFORED are called Kissabel. This interview was also useful to answer the sub-question 2.

Then another interview was done in Madrid. Jürgen Braun the general manager of KIKU and Braun Vivai. The Red Moon apple was bred by Jean-Luc Callier and Benoit Escande. The group KIKU bought the exclusive right for this variety. At the moment KIKU group is the owner of the red flesh variety, that means the group controls the plantation, the selling and the marketing strategy. The aim of this interview was to collect data about the breeding program and information regarding the marketing strategy.

The next step for the research was an interview with Pierre Clos. He is the manager of a fruit company in the French Alps called SICA Pom'Alpes. Few years ago, his company bought the exclusive licence for production and commercialisation of a red flesh apple called Red Love. This apple was developed in Switzerland by Grüber Genetti. This interview was useful to collect data for this sub-question 1 research, but also for the sub-question 2 and 3 agronomic and sales.

Another plan was to interview and visit the CIV (Consorzio Italiano Vivaisti) located in San Giuseppe on the East-Coast of Italy. The CIV is a research centre which breeds and develops new varieties of apples, pears, cherries and strawberries. This centre is the property of three major nurseries in Italy, Tagliani Vivai, Mazzoni and Salvi Vivai. After a phone contact with the CIV, they explained that any red flesh breeding program were started.

Sub-question 2: Agronomic

To answer this question, information was focused on the management of orchards of red flesh apples. Concerning the technical aspects, many key points were approached such as: flowering, chemical thinning, if these new varieties are more sensible to pest and diseases, harvest time, average yield per hectare.

During the placement in Rivoira company, much information was collected and ideas exchanged with the technician during our dairy tasks. Alessandro Rizzato is the technician who manages the experimental orchard of Rivoira, where red-flesh and many other varieties are under investigation. Rivoira is involved in the breeding program of IFORED since 2012. An interview was realized with him regarding the technical aspect of the red flesh orchards.

Furthermore, we planned a meeting with the director of SICA Pom'Alpes located in Manosque near the French Alps. Few years ago, this society bought the exclusive right to produce and sell a red flesh apple called Red Love. In contact with the director Pierre Clos, a meeting with him was organized in Madrid to accumulate information regarding other red flesh apples.

Sub-question 3: Health

To answer this part, the plan was to analyse nutritional value of different type of red flesh varieties and compare them to classic varieties such as Gala or Golden. The result of the question, are red flesh apples better for the health compare to white flesh apples, was easy to answer if data were present.

During the first interview with Jürgen Braun (Red Moon apple), he gave me a very interesting website. The research centre of Laimburg near Bolzano did analysis to show the nutritional value of more than seventy different apples variety. The value of Red Love and Red Moon was available on the website but not Kissabel fruits. They were not present on the website. According to Dr. Walter Guerra, department of fruits growing, nutritional values of Kissabel apples are still confidential.

After collecting some very interesting data on the previous web site, desk research was done to explain some technical word. Indeed, composition red flesh apple presents some new component. An explanation of them, about their role was done to provide information and make the text understandable for all kind of readers.

Sub-question 4: Sales

This question is focus on the sales aspect of red flesh varieties. In order to have an overview the data for this sub-question were gather in two different way. The first was regarding from the purchasers from the large retailers and the second was concerning the final consumer. This choice was done to obtained the most complete answer.

First, interviews were done with purchasers of large retailers. The aims of these interviews were to know if the supermarket should reference a range of red flesh apples. The visit to Fruit Attraction in Madrid in October was a great opportunity to meet purchasers from different European supermarkets. At this trade fair all actors of the fruits and vegetable-chain were present, following the same concept as Fruit Logistica in Berlin. A first interview was realized with Alfredo Martinez who is the purchasing manager of apples and pears from Mercadona, a group a supermarket located in Spain. A second was done with Jean-Louis Mouneyrac a purchasers and sellers of Mouneyrac company a wholesaler in Rungis, Paris. Then, the last interview was realized with Francois Lauferon the purchasing manager of Intermarché, French supermarket.

The second part concerned the point of view of the consumers concerning the red flesh apples. To know it, the plan was to go in different supermarkets in Europe and did a fast interview, small number of questions, with the consumers of fruits and especially apples. For these investigations, it was important to visit supermarkets in different part of Europe. In Italy, in the Netherland and in France twenty people per countries were interviewed thanks a short survey. In total, around sixty answer were collected all over Europe.

Furthermore, during the interviews with breeders (Red Moon, Kissabel and Red Love), data about the marketing strategy of each variety were collected. Each variety has a marketing strategy and their answers were useful in this sub question.

III. Results

In this chapter, the results obtained during the research phase will be exposed per sub-question according to the methodology used and presented in the previous chapter “Materials and methods”.

Sub-question 1: Research

How did researchers discover and further develop the red-flesh apples?

To answer to this sub-question, desk research was first used in order to understand breeding and to gather data from scientific articles which have been mentioned in the chapter Materials and Methods. Then interviews were realized at the Fruits Attraction in Madrid from the 15th till 17th October. For this sub-question, three interviews were done with the three most advanced breeding programs. The table below summarizes the characteristics of each program.

For all the breeding, it is natural crossing and not a GMO (Genetically Modified Organism). The story started in the 1990's when scientists found the gene of the red coloration in an apple tree forest in Kazakhstan. The gene was in a red flesh apple, but this apple did not have any taste, astringent and acidic. To improve its taste, scientists decided to cross the original red-fleshed apple with commercial white-fleshed varieties sweeter and tastier. This new apple variety was developed through selective breeding. Using new technology, breeders could now use genetic information to make the breeding process faster and more efficient. After more than 20 years of research, only few varieties were selected by the breeders. (Ennis, 2011)

The table below is a comparison between the three breeding programs, Red Moon, Kissabel and Red Love. It presents the number of cultivars for each program. It describes the orchard superficies, that means commercial orchard already implanted. Then, a description of the colouration inside and outside. There are two type internal colouration, the type 1 and 2. Regarding the type 1, the red coloration inside the fruit is 100% red from the flowering till the harvest. With the type 2, the fruit is white during all the cycle, the red coloration inside appears two weeks before the harvest.

The next criterium of comparison is the resistance of the cultivars against diseases. The first disease is Scab. It is a fungus that grows in spring with moist conditions and attacks the leaves and fruits. The damage of scab are black spots on the leaves and on the fruits. (Omafra, 2011). The second disease is fire blight. It is a disease, it is caused by a bacterium called *Erwinia amylovora*. The flowering period is the most sensible because the bacteria enters in the trees through the scars left by the fall of the petals. Damage are the flower buds dry out and turn brown, and the young twigs, more sensitive, curl and dry. (Prengaman, 2018)

The following criterium in the table is the productivity. This line compares the level of production between the cultivars. With red flesh varieties, the production is lower compared to classic white flesh varieties. An explanation of this lower productivity is explained in the next sub-question.

The last line studies the sensibility to alternance. This phenomenon of alternation could be described by the following example. One year the orchards will have lot of apples and so high yield, then, on the next year the production will be lower and harvest will be very small. This is calling the phenomenon of alternation. The aims of the grower, is to avoid this risk through thinning in order to have a regular production each year. The thinning is explained in the next sub-question.

Table 1: Comparison between three breeding programs

Commercial name	Red Moon	Kissabel	Red Love
Number and code of the cultivar	2 Cultivars: - RM1 - RS1	3 mains cultivars: -R201 (Red) -Y102 (Yellow) -Y103 (Orange)	2 Cultivars: - Red Love 1 - Red Love 2
Name of the breeding program	Escande nursery (France)	IFORED (France)	Grüber Genetti (Switzerland)
Orchards superficies in 2017	70 hectares	70 hectares	45 hectares
External colouration	Both are red	-R201 : Red -Y102 : Yellow -Y101 : Orange	Both are red
Type of coloration inside	Type 1	-R201 type 1 -Y102 type 2 -Y101 type 2	Type 1
Resistance against diseases	Both are scab resistant	-R201: Scab resistant and tolerant to Fire blight -Y102: Scab resistant -Y101: No resistance	Both are scab resistant
Productivity	- RM1: Low - RS1: Low	Unknown	- Red Love 1: Low - Red Love 2: Low
Sensibility to alternance	- RM1: No - RS1: No	-R201: Very high -Y102: Medium-High -Y101: No sensibility	- Red Love 1: Medium - Red Love 2: No



Figure 1 : Logo Red Moon



Figure 2 : Logo Red Love



Figure 3 : Logo Kissabel

IFORED research centre was the first breeding company to offer a range of red flesh apples called Kissabel with different external colour from red to yellow and orange. This factor is very important when apple will be sold in supermarkets.

The cultivar Red Love 1 was the first red flesh apple on the market. The research breed “quickly” this cultivar in order to arrive before the other competitors on the market. The result was not good. The feeling of this cultivar in the mouth was bad, with a thick skin and astringent. The second-generation Red Love 2 should taste better without the defects of the texture. The Red Love 2 will be less acidic than Red Love 1 and contains the same quantity of sugar.

The three varieties, Red Moon, Red Love and Kissabel are club variety. They are protected brands, only the members are authorised to carry out the production of the plants, the production and the sale of these fruits. Fruits must meet specifications and there should be no difference in appearance, taste and colour, regarding the origin of the production. To promote its fruits, each brand is represented by an association of producers, nurseries and marketers, who gathers resources in order to finance commercial and marketing actions.

The club has an incredible power to promote the variety and to keep the right selling price in order to give a better value to growers.

Sub-question 2: Agronomic

How to manage a red flesh apple orchard and what are the changes for the farmers compared to classic apples trees?

To answer this question, it is important to understand the management of a classic orchard before to go further. An example of a white flesh apple type Gala is done in the table below. The table resumes all the stages of the apple tree during one year.













When the winter starts, harvest is done and leaves are on the ground, the pruning can start. During this stage, workers will give form to the trees for the next season. This means keeping the bigger branches on the bottom and cutting strong branches on the top in order to increase the light.

The thinning aims to balance and optimize the number of fruits load on the trees to avoid the phenomenon of alternation over the next year. The phenomenon of alternation can be described by one year with a high yield and the next year the harvest will be very small. There are two ways of thinning, chemical and manual. At the flowering time, chemical products are sprayed to reduce the number of flowers. The spraying time start at the flowering till 14 mm fruits. In order to have a perfect harvest, manual thinning is often necessary. This way consists in making the fruit fall down by hand, realized from May to July when the diameter of the fruits is about 40 mms.

When the fruits are at the optimal colour and maturity, measured by starch level, sugar, firmness, the picking start. Harvesting is the most time consuming and labour-intensive activity.

On the following example, the variety is Gala a bicolour apple. The optimal density of plantation is 2 500 trees per hectares. The average production is around 50 to 60 tons per hectares. The lifetime of the orchards is approximatively 18 years. The reason of this shelf life is the colour. After much years, the external colouration of Gala apples will be lower due to degeneration of the old three. In comparison with a Gala (classic apple), the orchards management of red flesh apple is almost similar but key points need to be managed in another way. The recommended density of plantation is 2500 trees per hectares. Then, the production per hectare will be lower. Finally, the lifetime of the three is unknow for the moment.

Table 2: Technical schedule of apples cycle

GUIDE OF IN PHYTOSANITARY INTERVENTIONS																
MONTH	JANUARY	FEBRUARY	MARCH		APRIL		MAY		JUNE		JULY	AUGUST	SEPTEMBER	OCTOBER	NOVEMBER	DECEMBER
PHENOLOGICAL STAGE																
MANUAL WORKING																
PRUNING	Pruning top and bottom															
POLLINATION					Installation of beehive											
ANTI HAIL NETS							Opening								Closing	
MANUAL THINNING							Chemical thinning		Manual thinning							
HARVEST													Harvest			
MECANICAL WORKING (TRACTOR + TOOLS)																
SPRAYING			Scab, Oidium, Aphid, Codling, Halyomorpha halys (Shield bug).													
WEEDING			Weeding 1					Weeding 2			Weeding 3					

The table above is the technical schedule of apples cycle. It summarizes the work in the orchard in function of its stage. The first task is the pruning during winter time. Then, before the flowering growers installed beehive in order to increase the pollination. The next step is the opening of the anti-hail systems to protect orchards against hail. Followed by chemical thinning during the spring and then manual thinning. And finally, when the maturity of the apple is optimal, fruits are picked. Chemicals spraying are used during the cycle to protect the fruits against pest and diseases.

Pedoclimatic conditions.

In order to have a nice quality of fruits, the external and the internal coloration are essential. Along the interview, breeders and agronomist explain that the choice of the production area is very important. The pedoclimatic conditions are composed by the soil and the climate/weather. They will have an indispensable role concerning the colouration of the flesh. In the sectors of Angers, North of Germany and United Kingdom, the coloration inside and outside the apple corresponds to expected criteria. On the contrary, in Mediterranean area such as Spain, south of France or some parts of Italy, the colouration, inside the fruits, is not optimal.

The interviews with breeders and agronomist show that red flesh varieties required a certain level of humidity, a thermal difference between temperature of day and night and avoid hot temperature during summer. The selection of the right production area is an essential point regarding the production of red flesh varieties.

Number of fruits per tree

As mentioned previously, the external and internal colorations plays an important role in the production of red flesh apples. The number of fruits per tree will influence the colouration inside the apple. In general, in fruits production, the thinning aim to influence the number of fruits to optimize the calibre of the fruit, the production and to avoid the phenomenon of alternation over the next year. But with the new red flesh varieties, the thinning will have one more role: manage the red colouration inside the apples. The thinning is done in two part, chemical and manual. The chemical part is done from the flowering till the fruit 14 mm (April to May), and then the manual thinning in June. During the first part, products are sprayed on the flowers to burn them or the use of hormones aims to reduce the number of fruits. In function of the variety, the characteristics are different, some fruits could be well attached. In this case, an additional work with manual thinning could be required and increase the production cost.

More resistance, less spraying.

The scab is a fungus which grows in the spring under moist conditions. It attacks the leaves and fruits on which it proliferates forming black spots. The fire blight is a bacterium which attacks the tree which die quickly after infection. As explained in the first sub question, many red flesh cultivars are scab and one is fire blight resistant. The resistant varieties do not need to be sprayed against these fungi. On the example of Gala orchards, there is around seven treatments for the scab and three regarding the fire blight. However, the number of spraying regarding Scab and Fire blight is every year different because of weather. Thus, a stoppage of the spraying against Scab or Fire blight could be done

Less production

The last difference concerns the production of the red flesh orchards. The yield of red flesh varieties will be lower compared to classic apples such as Gala. The average yield of Gala is around 50-60 tons per hectare instead of 30-40 tons for the red flesh varieties. This lower yield is the result of an important thinning in order to increase the red colouration inside the apples.

To illustrate this fact, let's use the previous example on Gala. With this variety, the optimal number of fruits is 150. Then, as an average of 6 fruits are required for 1 kg. That means the production per tree is 25 kg multiply by 2 500 trees on 1 hectare: the total production on 1 hectare of orchard is around 60 tons.

Now, with the red flesh variety, the optimal number of fruits is 100. Then, as an average of 6 fruits are needed for 1 kg. That means the production per tree is 16 kg multiply by 2 500 trees on 1 hectare: the total production on 1 hectare of orchard is around 40 tons.

Other diseases

If these new apples are resistant to scab, on the other side they present other kind of diseases and problems which impact directly the quality of the fruits. These problems are in relation with lenticel breaking on the face of the apple, cracking in the peduncle and russetting on the top of the fruits. All the previous problems are not the consequence of an insect, fungus or diseases: they are abiotic. That means, they are the expression of the genetics. In some places, there will be the expression of genetics called phenotype. But on the others side, these problems appear or not in function of the place. Please find some pictures of theses abiotic problems in appendix 4.



Figure 4: R201 experimental orchards (Kissabel Red), province of Cuneo, Italy



Figure 5: Y101 experimental orchards (Kissabel Yellow), province of Cuneo, Italy

Sub-question 3: Health

Are there nutritional differences compared to classic apples and are red flesh apples healthier?

This sub question concerns the nutritional qualities of the red flesh apples. Because of their red colouration inside, the composition of the flesh is different from other classic apples. Apples are healthy anyway, they are high in vitamins and antioxidants, and red flesh apples could be even healthier. This is because they contain higher levels of anthocyanins, the compounds that make their skin and flesh red. This compound is not present in the classic white flesh apples.

The nutritional values are summarized in the table below. The data come from the research centre of Laimburg, Bolzano (Italy). Conventional apples such as Gala, Golden or Elstar are compared to red flesh varieties. The value of two cultivar from Red Love and two cultivars from Red Moon was available on the website but not Kissabel fruits. They were not present on the website. According to Dr. Walter Guerra, department of fruits growing, nutritional values of Kissabel apples are still confidential.

Table 3: Comparison of nutritional values between six different

	Gala	Golden Delicious	Elsar	Red Moon RS1	Red Moon RM1	Red Love 1	Red Love 2
Fruit characteristics							
Sugar (brix)	12	12,5	13,6	12,6	13,7	12	12,3
Acidity (g/L MA) harvest	3,7	4,5	8,5	12,8	13,5	12,3	9,3
Polyphenol contain (mg catechin/100 g)							
<i>Skin</i>	404,7	246,3	285,7	364,7	400	380,5	521
<i>Flesh</i>	81,2	64,4	54,9	114,2	201,8	72,3	180,2
Anthocyanin (mg Cyanidin 3-galactoside/ 100 g FW)	Only in red flesh varieties	Only in red flesh varieties	Only in red flesh varieties	41,7	12	15,4	23,47
Vitamine C (mg/100 g FW)							
<i>Skin</i>	2,7	11,2	8,1	18,5	12,7	12,8	11,3
<i>Flesh</i>	0,8	1,3	1,8	4,3	2,5	3,7	1

The first line of the table indicates the level of sugar of the apple, it is measured in Brix. The second line shows the level of acidity, it is measured in g/L MA, at the moment the harvest. The third line indicates the polyphenol contain in mg catechin/100g. This value is divided in two lines, the skin and the flesh. The choice to split these two values was done because of the different proportion of polyphenol in the fruits. The skin contains as an average two time more polyphenol than the flesh. The next line, the fourth, indicates the level of anthocyanin. Anthocyanins, member of polyphenols family, are present only in the red flesh apple because it is a compound of the red matter inside the fruit. An explanation regarding the role of anthocyanin is done later in this paragraph.

Then, the fifth line shows the level of vitamin C. Here also, this level was split in two lines because of the different proportion of vitamin C inside the apples. The proportion of vitamins C is much higher in the skin than the flesh. The last line is concerning the shelf life of the fruits in cold storage.

The role of Anthocyanins.

The anthocyanins are member of group of plant compounds, the phytochemicals. The presence of certain types of phytochemicals in some plants can act as a natural defence system providing protection against such things as attack from insects. In contrast, other plants produce phytochemicals that provide colour, aroma and flavour, thus inviting attention from potential consumers. In our case the anthocyanins, a type of phytochemical, is responsible for the red colouration inside the apple. When consumed, there is an increasing evidence to indicate that phytochemicals may reduce the risk of age-related chronic diseases such as coronary heart disease, diabetes, high blood pressure and certain types of cancer. According to (Sciences Learning Hub, 2011).

According to the table, the taste of red flesh apples will be more acidic and astringent. This is due because of the anthocyanins are odourless and astringent. Indeed, the level of sugar is similar to classic apples but the level of acidity is much higher. Then, the nutritional values of these new varieties are higher than the classic apples (Gala, Golden delicious and Elstar in the example). The quantity of polyphenols and vitamin C are higher. Then, the apparition of anthocyanin, which is present only on red flesh apples, increases the nutritional values. This could be an important argument in the marketing strategy of these varieties.

Sub-question 4: Sales

Is there a place in the consumer-market for these new apples?

As explained in the chapter “Materials and methods”, the research of information for this sub-question was done in two different ways. The first way was regarding to the purchasers from large retailers and the second was concerning the final consumer.

First part, results of the consumers

This part presents the results of the consumer survey made in three different countries France, Italy and the Netherlands. Along this survey sixty answer were collected. The survey was done in Conad in Italy, then in Albert Heijn in Netherlands and in Grand Frais in France. These three companies are different chain of supermarkets and present in its origin country. The results of this research are shown though circular graphic and bar graph.

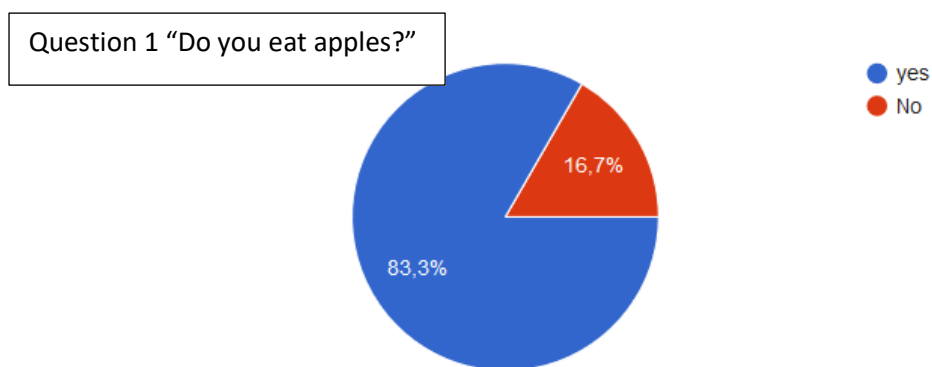


Figure 1: Answers of the questionnaire about apples consumption

This graphic above is the answer of the Question 1 “Do you eat apples?”. The result show that 83 % of the respondents eat apples. This answer is logical because apple is the most consumed fruit in Europe with 7.5 million of tons. According to (Fresh Plaza, 2018).

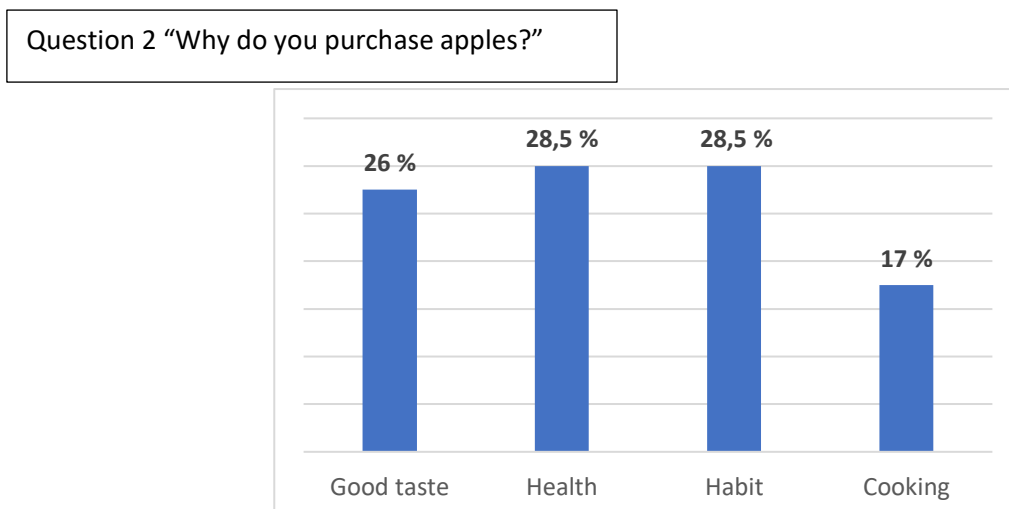


Figure 2: Answers of the questionnaire per the reasons of apples consumption

This bar graph above is the answer of the Question 2 “Why do you purchase apples?”. The two main answers of the question are “Health” and “Habit”.

Question 3 “Are you ready to eat red flesh apples?”

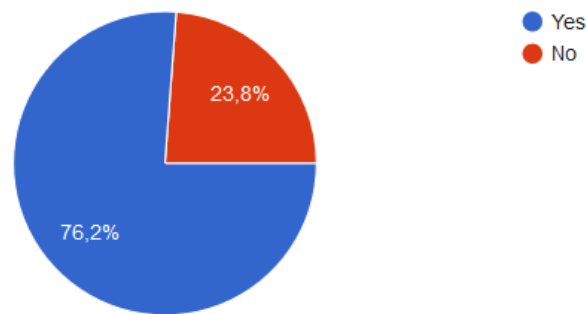


Figure 3: Answers of the questionnaire about attraction towards red flesh apples

This graphic above is the answer of the Question 3 “Are you ready to eat red flesh apples?”. It shows that 76 % of the respondent would like to try to eat a red flesh apple.

Question 4 “If yes, why. If no, why?”

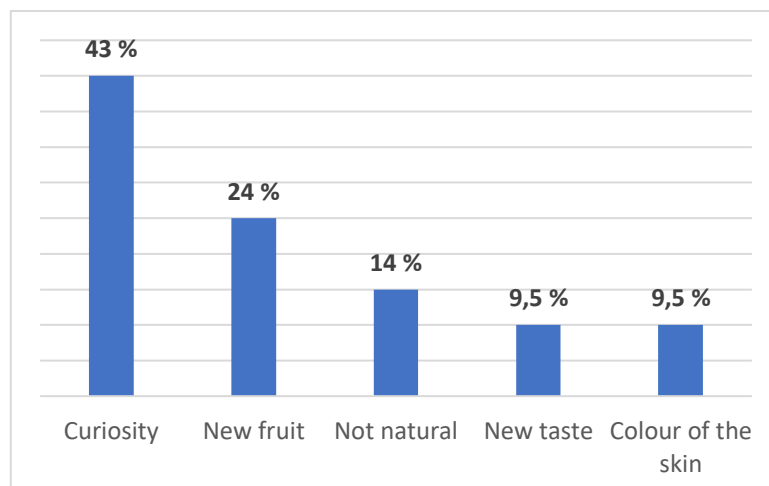


Figure 4: Answers of the questionnaire per reasons of attraction towards red flesh apples

This bar graph above is the answer of the Question 4 “If yes, why. If no, why?”, it shows the reason of the previous answers the question 3. 43 % of the respondent would like to try a red flesh apple by curiosity and 24 % because it is a new fruit. In the other side 14 % do not want to eat red flesh apples, their reason is that the fruit does not look natural.

Question 5 “What would you expect from these red flesh apples?”

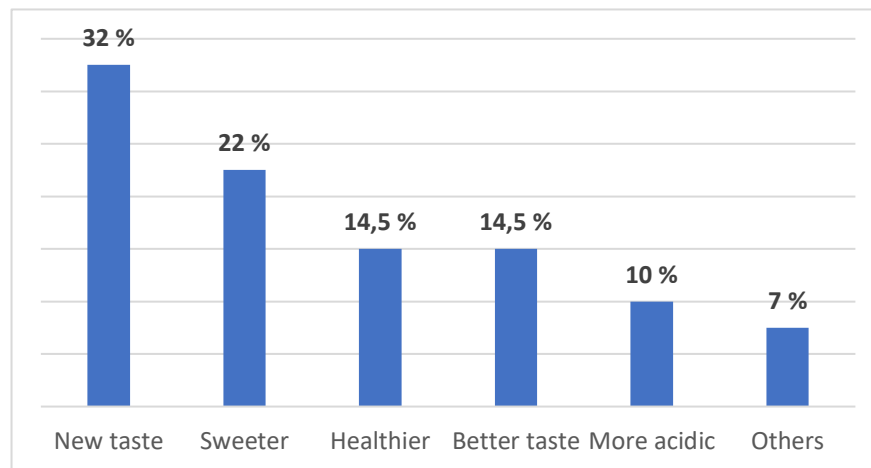


Figure 5: Answers of the questionnaire per the expecting taste

This bar graph above shows the answer of the Question 5 “What would you expect from these red flesh apples?”. It presents that 32 % of the respondent people expect a new taste of the apple and 22 % expect a sweeter apple.

If the results were split by countries, the conclusion is French and Italian expect a sweeter taste and on the other side Dutch people expect more acidic apples. This answer is logical, people from south Europe such as Italy, France, Spain prefer sweet apples and people from North Europe Netherlands, Scandinavia, United Kingdom prefer acidic apples.

Second part, purchasers from large retailers.

In a second part, the results of the survey 2 realized with the purchasers of the large retailers are explained. This survey is done to collect information and opinions of purchasers of fruits from different supermarket regarding the red flesh apples.

All the interviewees are always looking for new varieties of fruits or novelties, the aim is to increase the sales. In this case, novelty could be a “bleu apple” said Alfredo Martinez from Mercadona. This novelty has to be different from the others products and have a good taste. The attraction is not only by the visual aspect the notion of the taste is very important for the consumers.

The three purchasers are interesting in referencing red flesh apples, but with certain conditions. The variety need to have a good taste and a strong marketing has to be done to promote these fruits. The marketing will help to distinguish classic red apples from red flesh fruits and the good taste will be used to win the loyalty of the consumers. “The problem is that there is no difference at the first sight the consumer is not able to see the difference” According to Francois Lauferon from Intermarché.

Regarding the question if the red flesh apple could reverse the negative trend in apple consumption the answers are qualified. "People are not going to eat more apples because they are red inside." Said Jean-Louis Mouneyrac from Mouneyrac wholesalers. He thinks that the red flesh consumption will be a trend with a starting point and an end. Alfredo Martinez, agrees that the red flesh apples could increase the sale with a strong marketing campaign.

The wholesaler Mouneyrac already try to work with the Red Love variety. This test was not concluding. They had difficulties to buy the fruits, then the taste was not good and at the end it was difficult to resell the fruits. Mercadona supermarket was contacted by the Spanish company Nufri and the Italian VOG. The aim was to present their range of red flesh fruits. The both company Nufri and VOG are a partner IFORED program (Kissabel apple).

IV. Discussion of results

The work along this thesis was to determine the impact in the future of these new varieties on the market. With a consumption of apples decreasing in Europe, the research aim was answering the question if red-flesh apples have the potential to reverse the actual trend. In this way, the final objective was to propose solutions and guidelines for companies which plan to grow and sell these red flesh apples.

In this chapter, there will be two points of discussion: the methodology and the results. The chosen methodology for collecting data and further answering questions was the qualitative research. Interviews were realized with breeders, agronomists and purchasers from the large retailers. In order to structure the interviews, three different type of surveys were used to adapt the questions with the interviewee.

Sub-question 1: Research

How did researchers discover and further develop the red-flesh apples?

The research of data for this sub question was done mainly by interviews and a smaller part by desk research. Few weeks before the international fair in Madrid, a selection of potential meetings was done. The major part of the breeders agrees for this interview with a student.

The only one who declined the interview was the CIV. Consorzio Italiano Vivaisti located in San Giuseppe on the East-Coast of Italy. The CIV is a research centre which breeds and develops new varieties of apples, pears, cherries and strawberries. This centre is owned by three major nurseries in Italy: Tagliani Vivai, Mazzoni and Salvi Vivai. After a phone contact with the CIV, they explained that a red flesh breeding program was not started yet but they think about it.

Finally, three interviews were confirmed with three different companies from three different countries, about 3 varieties: Red Moon, Red Love and Kissabel. Thanks to the fair Fruits Attraction in Madrid during 15th -17th October, the interviews were realized in a perfect way. The three meetings were done at their exhibitors stand.

Thanks to the survey, enough reliable data were collected. The desk research was done to bring an external point of view, from scientific point of view, different from the three other meetings. These results are similar than what was stated in the theory.

By using all these different sources, it was difficult to write in a logical and comprehensive way about the results of this research. Moreover, there are many ways of representing results. The choice of coding method recommended by some teachers was not selected, considered too complex. The selected method was a table, who provides a clear overview and summarizes the three breeding programs. Furthermore, a descriptive text provides additional information about the research on these apples.

Sub-question 2: Agronomic

How to manage a red flesh apples orchard and what are the changes for the farmers compared to classic apples trees?

This sub question was answered through interviews realized with the three breeding companies and one agronomist. The choice to have a meeting with an agronomist was decided after the meeting with breeders. The agronomist was Alessandro Rizzato, the technician in charge of the experimental orchard of Rivoira, where red-flesh and many others varieties are under investigation. Rivoira is involved in the breeding program of IFORED (commercial name Kissabel) since 2012. An interview was realized with him at the end of October, regarding the technical aspects of the red flesh orchards.

The reason of this interview was to bring an external point of view, different from the breeders whose role is to promote and sell new varieties.

Thanks to the interviews with the breeders a big amount of information was collected. The interview with agronomist bring some new data but the more important, he gave another vision sometimes different from the breeders.

The difference with a classic orchard will be the pedoclimatic conditions, a right selection of the production area is important. Then, regarding the orchards, the number of fruits per plant will be lower to have a nice quality of fruits, thus the production of the orchards will be lower. The major parts of the cultivars are resistant against the scab, that mean growers will reduce spraying.

An aspect which had not been studied is the purchase price from producers. Indeed, it constituted an important criterium which, for the final selling price presented to customers but also for the development of the variety. If it is not profitable, growers will not plant orchards. Moreover, when discussing with the breeders, they mentioned the price and stated that red flesh apples' price would be higher than other classic apples like Gala. This is due to the lower production of the red flesh orchards. Thus, it could have been useful to study this aspect in order to have deeper insights of the red flesh apples' sales strategy.

In this sub-question, difficulties were encountered in selecting a good way of representing the results. For this sub question, a table is used to present the cycle of production on the example of apple Gala. Gala was selected because is the most famous bicolour apple and similar to the red flesh varieties. Then, this table is used to describe the essential points of the production. Finally, the differences between Gala orchards and red flesh orchard are enunciated and described in paragraphs.

Sub-question 3: Health

Are there nutritional differences compared to classic apples and are red flesh apples healthier?

This sub-question studies the nutritional values of different apples. Classic white flesh apples are compared to red flesh apples. This sub-question was answered through desk research and particularly on specific websites found. During the interview with Jürgen Braun, manager of the Red Moon variety, he referred to a very interesting website. This website come from the research centre of Laimburg. It is located near Bolzano in Süd-Tyrol (North of Italy).

On this website, more than seventy apples varieties are analysed. The website presents the nutritional and agronomic characteristics. The value of Red Love and Red Moon are available on the website but not Kissabel fruits. These were not present on the website. It was problematic because all the data from the other cultivars were present but not the data from Kissabel, that mean the comparison between cultivar was not totally complete.

In order to answer this problem, the name and the e-mail address was found on the website. It was Dr. Walter Guerra, department of fruits growing of Laimburg research centre. After a mail contact with Dr. Walter Guerra, he explained that nutritional values of Kissabel apples are still confidential. The decision to continue the comparison was done without the value of the apples Kissabel.

Thanks to this website, many reliable data were found. The next step was to summarize this data and make it clear. The desk research was done to explain the role of the new component of the red flesh apples.

The data were summarised in a table, Gala, Golden and Elstar were compared to the two cultivars of Red Moon and the two cultivars of Red Love. Then, desk research was done to explain some technical aspects and expressions. Indeed, the composition of red flesh apples presents some new components such as Anthocyanin. An explanation is added about the role of this component, to provide additional information and make the text understandable for all kind of readers.

However, during the interview with Jürgen Braun, Red Moon apple, he gave a different vision of the marketing regarding the high nutritional values of red flesh apples. He explained that in the marketing strategy of Red Moon, they do not want to tell red flesh apples are better for the health compared to classic white flesh apples because apples are healthy anyway. The risk is to destroy the market of classic varieties because consumers will think that others apples are less nutritive, which is false.

Sub-question 4: Sales

Is there a place in the consumer-market for these new apples?

As explained previously, the research of information for this sub-question was done in two different parts. The first way was regarding to the purchasers from large retailers and the second was concerning the final consumer.

For the first part, purchasers from large retailers, interviews were realized during the fair Fruits Attraction in Madrid 15th -17th October. In total three were done, two with purchasers from supermarket in France and Spain, then the last one was done with a wholesaler based in Rungis.

Thanks to all of them, many information was collected. Even with these three different interviews, the collected answers were almost similar. They are ready to introduce red flesh apples in their supermarket in order to increase sales and bring a new product but has only one condition: a good taste. Then, the descriptive way was selected to represented the results.

Regarding the second part, fast survey with consumers in supermarket were done in three countries. The survey was done in Conad (Italy) then, in Albert Heijn (Netherlands) and in Grand Frais (France). The aim was to collect the point of view from the final consumers. In total more than sixty answer were gather. For the representation of the results, the choice of circular graphic and table graph was a foregone conclusion. One graphic for each question were done, they provide clear overviews.

The results of the question 3 “Are you ready to eat red flesh apples?” were a success, more than 76 % of interviewed would like to try them. But the answer “no” was the response of many older people who have theirs habits and they do not want to try novelty, here the new red flesh varieties.

Regarding the methodology of the fast survey in supermarket, something probably influences the answers of the consumers. The place selected was fruits and vegetable area in supermarket. If people are present in this area that means they eat fruits and vegetables. If the survey was done in the street or in others place the results could be different. It could have been better to select a neutral place could provide better answer. But on the other side people were more receptive in supermarket than in an other place.

V. Conclusion and recommendations

The first part of this chapter will be the conclusion which summarize the four sub-questions and the answer of the main question **“Till what extend red-flesh apples can reverse the negative trend in European apple consumption and become the varieties of the future?”**. In a second part of this chapter, the recommendations per sub-question will be expose.

Conclusion

As explained at the beginning of this document, the consumption of fresh apples is decreasing in Europe. An alternative found to reverse this negative trend is to bring a new apple variety on the market. This new variety should be attractive by a difference from the others already present on the market. One of the solutions could be the introduction of red flesh apples.

The breeders selected the best cultivars in the last twenty years and nowadays, trees are ready to be planted in commercial orchards. Each breeder had developed his own club variety through a commercial brand. Regarding the agronomic aspect, red flesh apples can be produced on a large scale and sold in supermarkets in order to be known by the most final consumer. In fact, the production of the fruits is almost similar to the classic white flesh apples. Regarding the nutritional values, in general apples are well-known as healthy fruits. However, the red flesh apples are even better due to red matter inside the fruit composed by anthocyanins. Regarding the sales aspect, the results of the survey with consumers in supermarket were a success, it shows that 76 % of them would like to eat red flesh apples. The main reason of this attraction is the curiosity effect (43 %) because it is a new product on the market. Concerning supermarket, purchasers are always looking for the novelty in order to improve the attractiveness of their shops. Purchasers who were interviewed share the same feeling regarding the new red flesh apples: they have to be tasty, the taste is as much as important than colour inside and outside. They agree that the new varieties should be promoted by an important marketing strategy provided by the club association.

Thanks to their colour inside and outside, high nutritional qualities, a strong attractiveness and their originality, red flesh apples have a strong potential. But the red flesh apples could not totally reverse the trend. The main reason is that when a consumer buys red flesh apples, he/she will substitute another variety for the red flesh apples. Thanks to the information collected, the average of a classic consumer is four apples (same variety) a week. With the red flesh apples, a consumer does not eat more apples, he/she will substitute one variety to a red flesh variety; for example, two apples golden and two red flesh apples. Thanks to this demonstration, the apple consumption will not increase, only the proportions of each variety will be different. However, thanks to their aspects such as Healthy lifestyle, red flesh apples could attract new consumers of apples. The introduction of new consumers will help to stop the negative trend and to stabilise the consumption.

Red flesh apples cannot reverse the negative trend of the fresh apple consumption, but they have a strong potential to become the variety of the future.

The role of the club variety will be to do marketing communication and to promote these fruits growers. There are many different ways to achieve these roles, which are further developed in the recommendation part. The final objective will be to win the loyalty of the consumers. At the beginning of their introduction on the market, there will be a curiosity effect. On the apple market, there is a demand from the consumer for the club variety such as Pink Lady or Kanzi. The marketing strategy done by the club influence the choices of the consumers. Thanks to all the factors enumerate previously, red flesh apple should become the future varieties of apples.

A relevant way to improve the consumption of fresh apples or fruits in general, in a long-term vision, is the education of the young generation to eat fresh fruits and not processed foods.

Recommendation

Research

With the red flesh apples new club varieties appear on the market: Kissabel, Red Moon and Red Love. The growers will be selected by the club in accordance with his good practise and the respect of pedoclimatic condition. But when a producer enters in one club, he cannot go in another one. Each club variety is managed by an association (nursery, growers, official marketer).

At the moment, there are not enough plants available for all the producers, varieties are new and nursery have to increase the production of threes in the next three years. Before entering in a club, the association should select the best growers and cultivars which are adapted to his production area. At this moment, growers adapt the production area to the cultivars.

There is no a best variety but in few years after the development, each area will have a kind of red flesh apples. One for the Mediterranean climate, one for moist climate for example.

Agronomic

As mentioned previously the selection of the production area is very important. Actually, the best areas are located in North of Germany, United Kingdom and North-West of France (Val de Loire). These regions provide conditions for a good colouration outside and inside the fruits.

Then, the optimal density of a red flesh orchards is similar to others variety, approximately 2 500 trees per hectares. The number of fruits per plant should be around hundred apples. If there are more, the inside colouration will be not sufficient and if there are less fruits, the yields of the orchard will be smaller. The most efficient way to control the number of fruits is to count 10 to 20 random trees per hectare to get an idea. Thus, the growers will decide to chemical or manual thinning.

Because of the resistance of some cultivars, growers could reduce the chemical crop protection. Resistance are concerning scab for the majority of the cultivars and fire blight for one cultivar. Producers should be able to reduce the number of spraying actions. In a conventional orchard, there are around seven treatments for scab and three regarding fire blight.

Health

The key of the success for these new apples is an “Healthy fruit” with a high level of anthocyanins, polyphenols and vitamins C. Health will be the most efficient point concerning the marketing strategy.

Sales and marketing.

The first objective of the marketing campaign into the supermarket will be “how to differentiate the red flesh apples from the other red apples?”. The marketing strategy from the club variety of red flesh apples, should be focus on this idea.

The first thing will be organise tasting in the supermarket directly with the final consumers to let the consumer discover these varieties. The costs of this demonstration could be split between the supermarket and the club association. The aim of this job will be to promote this new apple and inform consumers about the no GMO origin of the apple. Then, in order to identify red flesh apples at the first look, club variety association should use a nice packaging.

Then next advice will be to do some advertisement in the supermarket through poster or outside through social medias, newspapers, radio or TV. The target group of this advertisement will be the new generation of consumers who are more sensible and receptive to marketing communication, as they like innovation and healthy lifestyles.

The principal argument could be the better nutritional values of the red flesh and the attractivity of red colouration inside the fruits, which is a completely new apple on the market. But other argument such as less treatments is reliable.

Regarding the sales, recommendations are the following:

At the beginning of the introduction of these new varieties on the market, there will be a curiosity effect. Consumers will buy these fruits because there are new on the market and different from the others apples. The role of the supermarket will be to win and maintain the loyalty of the consumer. This will be done mainly by the marketing.

The role of the club associations will be to control the production. For the moment red flesh apple are a niche market. In order to win the loyalty of the consumers, the apples should be available all the year in supermarket, if not the consumer will buy another fruit. To achieve this goal, club varieties should develop orchards in the south hemisphere countries such as Chile, Argentina, South Africa, Australia or New Zealand. Thanks to growers located in south hemisphere, club varieties will be available all the year in supermarket.

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Appendix - Survey 1 Researchers and agronomists

My name is Hugo Mestre and I am a student of the AERES University of Applied Sciences in the Netherlands. Within the framework of my research, I make a thesis as final work for my European Engineer Degree. The chosen topic deals with new varieties of apples, especially the red-flesh varieties.

All the information collected along this interview will be useful to build my research.

Structure

- 1-Are red-flesh apples included in the production and/or breeding program of your company?
- 2-What is your range of red flesh apples? Could you describe which are important according to you?
- 3-What are the means or resources you have at your disposal (e.g.: cultivated area, number of plants, human, financial,) with regard to red-flesh apples?

Research

- 4-Where did the idea of production or breeding a red flesh apple come from?
- 5-When and where has your research or experiments started?

Orchards management

- 6-Compared to a conventional orchard (white-flesh), what are the essential key point(s) of your(s) variety(ies)?
- 7-How to improve the red coloration inside the apple?
- 8-What is the level of sensibility or resistance of your variety(ies) against pests and diseases?

Taste and health

- 9-What is your opinion concerning the taste of red-flesh apples compared to a bicolour fruit (white flesh)?
- 10- Are red-flesh apples better for the health? (The answer “One apple a day keep the doctor away” is not allowed....)

Marketing

- 11-Which commercial strategy could be the best for your(s) variety(ies)?

Example:

- Niche market and restaurants
- Wholesalers
- Supply central purchasing or supermarket through high volume
- Create a “club variety” such as Pink Lady or Kanzi
- National, European or Global?

- 12-Which marketing strategy will be implemented or set up to promote the sale?

- 13-Do you expect there is a considerable place in the supermarkets for these new red-flesh apples in general?

14-Red-flesh apple will be more expensive compared to the bicolour apple?

Appendix 2 -Survey 2 Purchasers from large retailers

My name is Hugo Mestre and I am a student of the AERES University of Applied Sciences in the Netherlands. Within the framework of my research, I make a thesis as final work for my European Engineer Degree. The chosen topic deals with new varieties of apples, especially the red-flesh varieties.

This survey is done to collect information and opinions of purchasers of fruits from different supermarket regarding the red flesh apples.

All the information collected along this interview will be useful to build my research.

Sales

- 1- Are you looking for new apple varieties to improve the attractiveness of the fruits department in your supermarket?
- 2- If yes, which one?
- 3- Are you interested to reference a red flesh apple?
- 4- Do you think red flesh apple could reverse the negative trend in apple consumption?
- 5- Did some company already contact you to start this kind of project?

Appendix 3 - Survey 3 Apple consumers

My name is Hugo Mestre and I am a student of the AERES University of Applied Sciences in the Netherlands. Within the framework of my research, I make a thesis as final work for my European Engineer Degree. The chosen topic deals with new varieties of apples, especially the red-flesh varieties.

This survey is done to collect information about the point of view of the consumer regarding the red flesh apples in the supermarket.

All the information collected along this interview will be useful to build my research.

- 1- Do you eat apples?
- 2- Why do you purchase apples? (Health, good taste,)
- 3- Are you ready to eat red flesh apples?
- 4- If yes, why. If no, why?
- 5- What would you expect from these red-flesh apples? (new taste, better taste, more sugary, healthier, ...)

Appendix 4 – Picture of red flesh apples



Figure 11: R201 (Kissabel Red), cracking and russeting on the top of the fruit.



Figure 12: R201 (Kissabel Red), problem of lenticel on the surface fruit.



Figure 13: Y101 (Kissabel Yellow), problem of epidermis on the top of the fruit.



Figure 14: R201 (Kissabel Red), after the flowering, size 20 mm



Figure 15: Tray of R201 Kissabel Red



Figure 6: Tray of Y103 Kissabel Orange



Figure 17: Tray of Y101 Kissabel Yellow

Appendix 5 - List of contact details



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