



Faculty of Education and Science

Akriti Kuikel

Master Thesis

Natural antioxidants as a new food preservative

Master in Commercial Biotechnology

2022

Consent to lending by University College Library YES NO

Consent to accessibility in digital archive Brage YES NO

Acknowledgment

It is a great pleasure to acknowledge my special thanks and gratitude to my supervisor Nis Valentin Ladefoged Nielsen, Inland Norway University of Applied Science, for his unconditional support, patience, guidance, and encouragement throughout my thesis. It is a great honor to work under his supervision.

I would like to thank all the professors and staff of the Inland Norway University of Applied Science for their valuable suggestions and guidance throughout my Master's studies.

I owe and respectfully offer my deepest thanks to my noble parents for their constant moral support and guidance, which helped me to achieve success in my life, and without their kind devotion, this thesis would have been a sheer dream.

I would also extend my special thanks to all those who have directly or indirectly helped me in completing my thesis successfully.

Akriti Kuikel

Abbreviations:

ADI = Acceptable Daily Intake

BHA = Butylated hydroxyanisole

BHT = Butylated hydroxytoluene

CA = Citric acid

CAGR = Compound annual growth rate

CBE = Circular bioeconomy

CNCL = Cashew nutshell liquid

EFSA = European Food Safety Authority's

FAO = Food and agriculture organization

GRAS = Generally regarded as safe

JECFA = Joint FAO/WHO Expert Committee on Food Additives

LPO = Lipid peroxides

NOAEL = No-observed-adverse-effect level

PG = Propyl gallate

PP = Potato peel

PPE = Potato peel extract

PPW = Potato peel waste

QC = Quality control

R & D = Research and Development

TBHQ = Tert- butylhydroquinone

WHO = World Health Organization

Table of Contents

<i>Acknowledgment</i>	3
<i>Abbreviations:</i>	4
<i>Table of Contents</i>	5
<i>List of Tables</i>	6
<i>Abstract</i>	7
1. Introduction:	8
1.1. Type of antioxidant:	9
1.2. Natural vs synthetic food preservatives:	10
1.3. Bioprocess engineering of potato peel:	11
1.4. Market for natural antioxidant:	12
1.5. Circular bioeconomy of potato peel:	13
1.6. Food additives and Regulatory approval:	14
1.7. Aims and Objectives:	16
2. Methods:	17
2.1. Market segmentation:	17
2.2. SWOT analysis:	18
2.3. Business model canvas:	18
2.4. Porter’s five forces:	19
3. Results:	20
3.1. Market segmentation:	20
3.2. Beachhead market selection:	23
3.3. SWOT analysis:	26
3.4. Osterwalder’s business model canvas:	28
3.5. Porter’s five forces for the potato peel antioxidant:	30
4. Discussion:	34
4.1. Regulatory approval of food additives:	36
4.2. Choice of suitable target market:	37
4.3. Competitive analysis:	38
4.3.1. Analysis of SWOT table:	39
4.3.2. Analysis of Porter’s five forces:.....	40
4.4. Business model canvas:	42
5. Conclusions and Recommendations:	47
<i>References:</i>	49

List of Tables

Table 1: Market segmentation of potato peel antioxidant.....	20
Table 2: Comparison of cosmetic, pharmaceutical and food industry by market size, CAGR, and competition	23
Table 3: SWOT analysis of potato peel antioxidant company.....	26
Table 4: Business model canvas for potato peel antioxidant as a food additive:.....	29

Abstract

Antioxidant is indispensable to hinder the oxidative damage of the lipid to maintain the product's safety and superior texture, odor, color, and nutritional value. The demand for antioxidants is increasing globally. Various plants and vegetables, including potatoes, contain some amount of the phenolic compound, which is useful for the production of the natural antioxidant. Potato peels have ten times more excessive phenolic compound as compared to their flesh. So, no value potato peel waste collected from different food industries can be reused to extract the high-value natural antioxidant. This study aims to design a suitable business model for the potato peel, a potential market entry strategy, and an analysis of a competitive force around the antioxidant industry. This study was based on the secondary data and information collected from different companies' websites, annual reports, google scholar, science direct, books, PubMed, etc. Various business tools were used for the analysis of the result. The potential market includes the food additives, pharmaceutical, packaging material, fuel, cosmetics, and plastics producing industries, and the food additives market was further split into different sectors. The suitable segment for the market entry was also evaluated after comparing different criteria such as market size, competition in the market, growth rate, and value proposition. The small to medium scale salmon industry inside Norway was a preferable beachhead market for the potato peel industry. A partnership with an established marketing company was figured out as a perfect market entry strategy for this company.

Keywords: Potato peel, natural antioxidant, market analysis, food additives, phenolic compound

1. Introduction:

Potato (*Solanum tuberosum*) is a very common underground stem plant with high carbohydrate, protein, vitamin C, and some amounts of carotenoids and phenolics, which can work as an antioxidant. Foodstuffs containing carotenoids and flavonoids are considered to decrease certain kinds of diseases such as heart disease, cancers, and macular degeneration. Figure 1 indicates that potato peel can be used in a various ways as it contains different kinds of useful compounds. Anthocyanins are the most common flavonoids found in the potato. The potato flavonoids can also be used as a natural dye industrially to color fabrics which is non-allergic, non-carcinogenic, biodegradable, and biocompatible (de Araujo, de Paulo Farias et al. 2021). The involvement of antioxidant-rich food leads to increase the antioxidant level in blood serum (Brown 2005). Potato is the 4th most common food globally and is recognized as “the king of the vegetables” as it is available in most of the countries in the world. In 2008, the annual production of the potato was 21.8 million tones (Singh, Sabally et al. 2011), and it increased to 1800 million tones in 2009 according to the Food and agriculture organization (FAO) (Weshahy and Rao 2012). Among them, more than half of the potato goes for further processing; 60% for the French fries production, 22% for the production of the chips, and 18% for other use. Normally, the production of the potato is increasing yearly by 5%. Potato chips are a very common product produced from the potato, which produces a huge amount of the potato peel after processing (Gebrechistos and Chen 2018). Various methods of potato peeling are used, depending upon the type of product produced, which produces 15% - 40% of the potato peel waste (PPW) of initial product mass (Igor Sepelev and Galoburda 2015). Potato peel (PP) contains ten times more polyphenols (which act as an antioxidant) as compared to potato flesh (Weshahy and Rao 2012). Eco-friendly product production is the need of society. The use of potato peel extract (PPE) as a natural antioxidant is the recent approach among scientists (Gebrechistos and Chen 2018). PPE is a cheap, affordable, and valuable by-product which consists of the huge amount of starch, non-starch polysaccharides, polyphenols, proteins, and lipids (Igor Sepelev and Galoburda 2015) (Weshahy and Rao 2012).

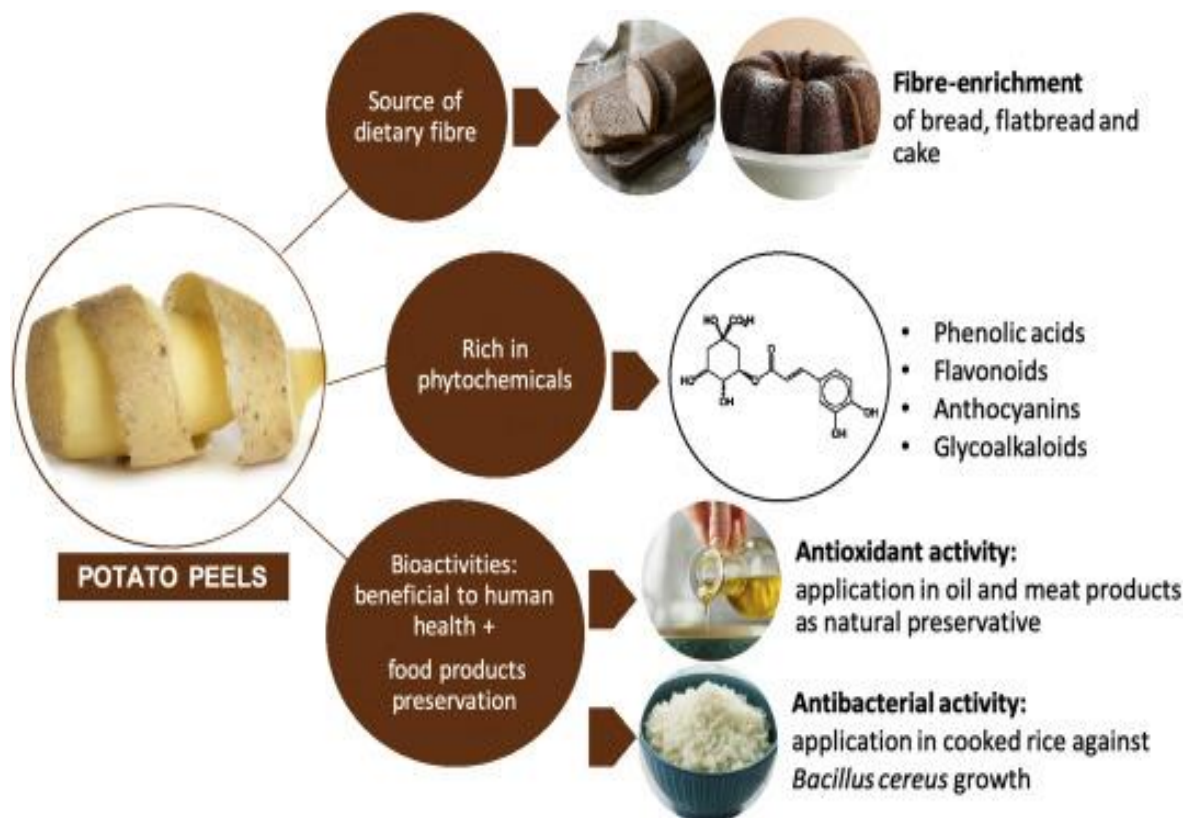


Figure 1: Content and use of potato peel

1.1. Type of antioxidant:

Antioxidants can be divided into synthetic and natural antioxidant as its type (Costa and Santos 2017).

- Natural antioxidant: The natural antioxidant can be defined as an antioxidant found in natural states that increases the shelf-life of the product by preventing the oxidation process. All parts of the plant, such as fruits, vegetables, nuts, seeds, leaves, roots, and barks with high phenolic components, can be used as a natural antioxidant source. Commonly used natural antioxidants are; vegetable oil which contains topo phenols and tocotrienols, cashew nut shell liquid (CNSL), leaf, potato peel extract (*Solanum tubersum*), soybean oil (Jemima Romola, Meganaharshini et al. 2021), olive (de Moraes Crizel, de Oliveira Rios et al. 2018), papaya peel (de Moraes Crizel, de Oliveira Rios et al. 2017), mango kernel extract (de Moraes Crizel, de Oliveira Rios et al. 2017), blackberry (Nogueira, Fakhouri et al. 2018), etc. The natural antioxidant derived from

plant sources can be categorized into three major categories: phenolic compounds, vitamins and carotenoids. In addition to the antioxidant property, some of the phenolic compound also contains antimicrobial and antifungal properties (G. K. Jayaprakasha, R. P. Singh et al. 2000, Ramírez-Jiménez, Guerra-Hernández et al. 2003, Elzbieta Sikora, Ewa Cieslik et al. 2008)

- b) Synthetic antioxidant: Those antioxidants manufactured through the chemical procedures are generally regarded as synthetic antioxidants. Even though synthetic antioxidants have elevated stability, excessive performance, broad availability, and cheap as compared to natural antioxidant, there has been safety issue comes around the synthetic antioxidant. Commonly used synthetic antioxidants in the market are; Tert-butylhydroquinone (TBHQ), Butylated hydroxyanisole (BHA), Butylated hydroxytoluene (BHT), Propyl gallate (PG) etc. (Jemima Romola, Meganaharshini et al. 2021)

1.2. Natural vs synthetic food preservatives:

Natural food preservatives are preferred over synthetic food preservatives as synthetic preservatives may produce carcinogenic effects (Gebrechistos and Chen 2018). It may cause swelling of the liver, and it can disturb the liver enzymes (Weshahy and Rao 2012). Synthetic antioxidants are toxic to the user if it is used in high doses. Butylated hydroxytoluene (BHT) and butylated hydroxyanisole (BHA) are the synthetics antioxidants which are most common to use as a preservative for food (Weshahy and Rao 2012). According to (Igor Sepelev and Galoburda 2015), BHT and BHA can cause blood clotting in high doses. Due to many health risks of synthetic antioxidants, there is always a vital necessity for the alternative antioxidant, which is safe for consumers. Natural food preservative has less side effect on human health and can be used in combination with synthetic preservative if required. Natural food preservative is reliable and environmental friendly with less health risk (Weshahy and Rao 2012). In addition, natural antioxidants are beneficial against neurodegenerative diseases because of oxidative stress. Among all antioxidants, phenolic compound is the most vital antioxidant due to the presence of high antioxidant activity and positive health effects in human, such as anticancer and antidiabetic effects. It also helps to prevent some diseases, such as diseases related to the

brain and heart, and it also helps to improve the immune system (Santos-Sánchez, Salas-Coronado et al. 2017).

1.3. Bioprocess engineering of potato peel:

Bioprocessing or bioprocess engineering is a process of changing biological materials into more valuable and useful products by upgrading nutritional value by fermentation technology by using enzymes and microorganisms which contain the production of food, feed and industrial chemicals (El Sheikha and Ray 2017). Nowadays, developing countries are practicing to transmute the agro-industrial waste into precious products (such as food additives, antioxidants, biogas, biofertilizer, dietary fibers, and bio-fuels) to fulfill the necessity of the society by the utilization of the numerous biotechnological procedures such as fermentation and extraction (Javed, Ahmad et al. 2019). By using fermentation technology, there are various potential products formed from PPW, such as ethanol, lactic acid, enzymes, and antioxidants (Igor Sepelev and Galoburda 2015). As potato peel can be considered a cheap and readily available zero value by-product, which contains huge quantities of cellulose, hemicellulose, and starch, it can be used to produce the bioethanol to use it as a form of biofuels (Richelle, Ben Tahar et al. 2015). As potato contains a considerable amount of potassium and phosphorus in its peel, it can be used as a biofertilizer (potassium- phosphorus sources) to improve the soil quality, enrich the soil and increase the soil fertility, and to increase crop yield. This kind of fertilizer will be cheap compared to traditional inorganic fertilizers, and this idea will be helpful for the management of the waste as well (Majee, Halder et al. 2021). Similarly, citric acid (CA) is another essential component that can be produced by using the potato peel. It is used commercially in different industries, such as 70% in the food industry, 12% in the pharmaceutical sector, and 18% in others. The demand for the CA increases, which leads to increase in its price (\$1.0 - \$1.3 per kilogram). Different strains of the *Aspergillus niger* are used for the production of citric acid. CA is approved by the World health organization (WHO) for the daily intake, and it is accepted globally as a GRAS (Generally regarded as safe) compound (Akbergenova, Cunningham et al. 2018). In addition, extraction of the antioxidant is another valuable product produced by the use of potato peel, which can be used further for the prevention of oxidation and to enhance the safety and stability of a wide range of substances.

1.4. Market for natural antioxidant:

Antioxidant has important use in the food industry for the stabilization of fats and oils, fat emulsions, and food packaging (Rahman 2007), in cosmetics product making company to make the product effective and stable (Soto, Parada et al. 2018), in biodiesel to lower the oxidation to prevent micro-explosion and fire hazard (Varatharajan and Pushparani 2018). The antioxidant can be released in the packaging to generate the bioactive packaging, which can protect products. Such kind of package is eco-friendly, and its advantages outweigh the petroleum plastic bags (de Araujo, de Paulo Farias et al. 2021).

The buyers of the antioxidant are located all over the world. The industrial chemical manufacturer, plastic manufacturer, vegetable oil producer, health and pharmaceutical product producer, rubber producer, industrial chemical producer, food, feed, and beverage producer, and seafood producers are the primary buyer of the antioxidant around the world (go4WorldBusiness). There is a strong need for green feed additives in animal feed after the use of antibiotics has been banned in several countries. Therefore, many feed additives company demands for a natural antioxidant to produce nutrient supplement (for better animal health) and to produce high quality nutritional value feed material (Qiao, Zhou et al. 2012). After the adverse health effect of the synthetic antioxidant has been detected, the industries and the governmental policies shifted towards the natural antioxidant. The meat industry is also a major antioxidants buyer that utilizes antioxidants to enhance the meat's nutrition and safety, maintain meat quality, and lower carcinogenic effects. Marine food business is also a buyer of antioxidants in large quantities. Various method of preservation has been in use for the protection and preservation of marine food, such as freezing and frozen storage. But the enzymatic and non-enzymatic rancidity alter the shelf life of the foodstuff. So, the companies are using antioxidants for preservation, color stability, and odor maintenance (Howes, Milazzo et al. 2019). One crucial factor that enhances the market demand for natural antioxidants over companies is the multipurpose and multifunctional nature of antioxidants. Not only to prevent oxidation, but a single antioxidant can also act as an antimicrobial and an anti-inflammatory agent in a product. So, the companies can use one compound for multiple purposes (Ciriminna, Meneguzzo et al. 2017).

1.5. Circular bioeconomy of potato peel:

Circular bioeconomy (CBE) is the use of waste materials after producing the main product for the formation of the high value bio-based by-product. The main aim of the circular bioeconomy is to minimize the waste production as much as possible by maintaining the value of the by-product. CBE is the best approach for waste management and recycling, which reduces negative environmental impact. It is an environmental friendly approach (Stegmann, Londo et al. 2020). Potato peel contains lots of fiber. So, it is hard to digest without further treatment for non-ruminants. It is currently used as a feeding material for the multi-gastric animals in various places (Weshahy and Rao 2012). According to (Igor Sepelev and Galoburda 2015), PPE can also be utilized to generate bakery products as a source of dietary fiber. The use of PPE in bakery products helps to decrease the quantity of flour by 10%. Potato peel has many more uses than it is used in the current situation, such as food preservatives (antimicrobial, antioxidant), pharmaceutical ingredients (wound management, glycoalkaloids), sources of renewable energy (biogas production), and animal feed (Gebrechistos and Chen 2018). It can also be utilized for the extraction of phenolics, antioxidants, fermentation substrates, biopolymers, edible coating, and food additives (Muthurajan, Veeramani et al. 2021). In addition, it has bactericidal and bacteriostatic effects (Weshahy and Rao 2012). PPW is considered an important among other natural sources of antioxidants because it contains three times more antioxidant level than other plant tissue (Igor Sepelev and Galoburda 2015). As shown in Figure 2, after the production of the main product (potato chips, fries), the by-product (potato peel) can be utilized as a dietary fiber in bakery product or can extract various valuable chemicals or can produce antioxidant (which has a potential for active packaging production, food preservation, cosmetic product protection, biofuel protection and many more). The only challenges about the circular bioeconomy of the potato peel extract are the rules, regulations, policies, and some ethical acceptance of the waste according to the legislations (Stegmann, Londo et al. 2020).

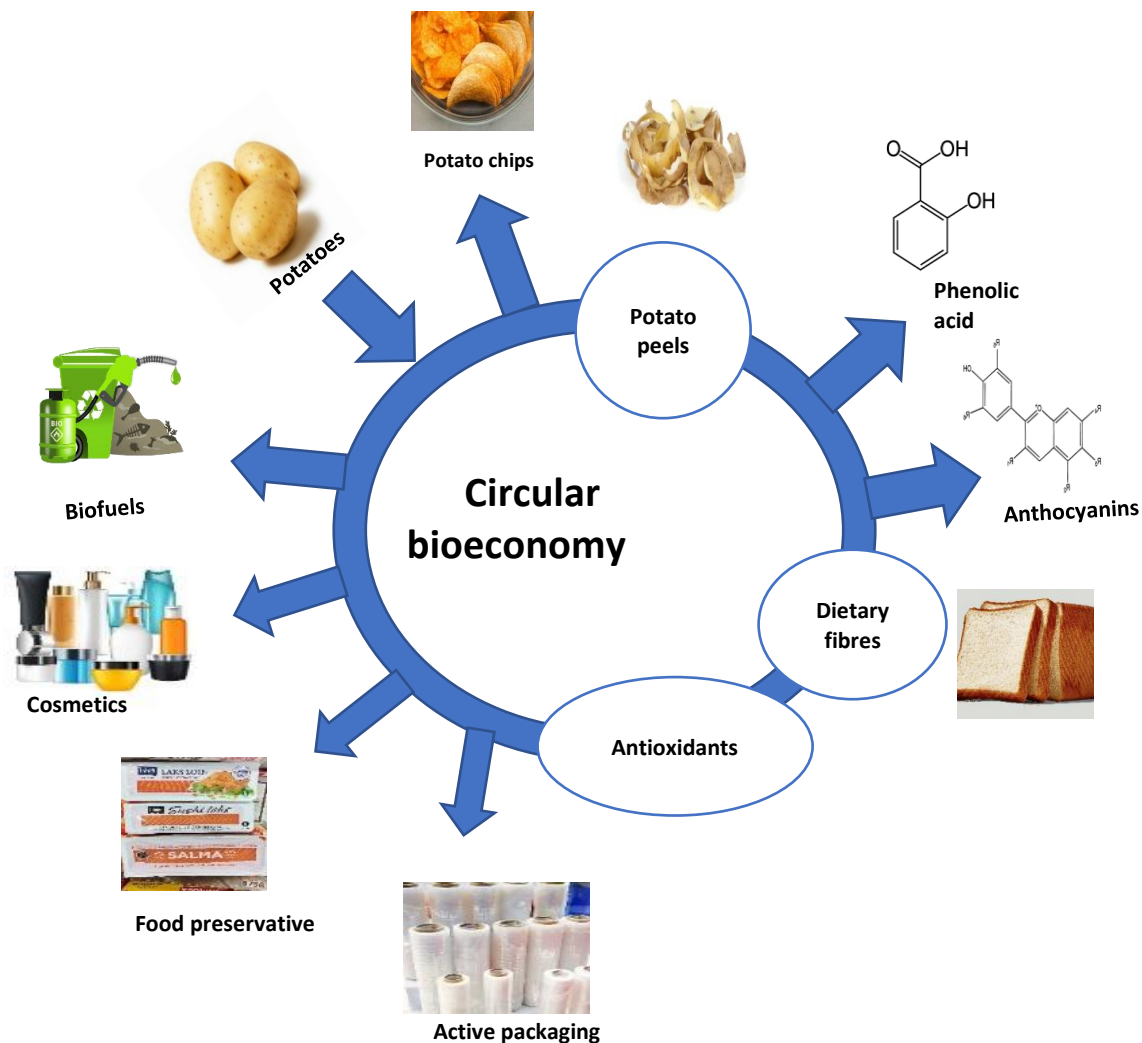


Figure 2: Circular bioeconomy of potato peel

1.6. Food additives and Regulatory approval:

Food additives generally refer to any substances added to the food to enhance its flavor, appearance, freshness, taste, texture, or to preserve it. Different practices were done in the past to preserve the food particle, such as smoking, use of vinegar, oil, alcohol, etc. But in recent

time, there are a huge variety of chemical, and natural preservatives available in the market, which can be considered as a good thing for modern society with high food demand, but the safety of the consumer also cannot be neglected. There are three main organization that looks towards the approval and safety of the food additives, namely, the joint FAO/WHO Expert Committee on Food Additives (JECFA), the European Food Safety Authority (EFSA), and the United State Food and Drug Administration (FDA).

The local government and organizations are responsible to inspect the safety of the new food additives and their approval depending upon the country. The premarket approval process of the new food additives starts by the company produce the additives and file a petition for the approval. The petition should include many details such as information about the additives (chemical composition, chemical identity), purity of additives, physical and biological property, information about the by product, impurities present in the additives, preparation procedure, information about the manufacturer, stability of the additives, information about environmental effects, and right concentration of the use, etc. (A. Larry Branen, P. Michael davidson et al. 2001). In addition to this, the petitioner must deliver the evidence that the formulated additives will work as it is deliberated. The studies of the effects of the additives in humans and animals can also be submitted. The responsible organization analyze all the presented documents along with intended amount consumed per day, potential short-term effects, long-term effects, toxicological studies, and safety of the consumer. Scientific knowledge available in various sectors is also use during the evaluation process (Jim Schonrock, Sean Sands et al. 2008). Risk assessment is a crucial aspect for the maintenance of the user's safety. It simply includes the identification of hazards (detection of the possible health effects), dose-response assessment, and risk characterization. Determination of the maximum use level of food additives in various food groups is essential to ensure that it does not exceed the acceptable daily intake (ADI) (A. Larry Branen, P. Michael davidson et al. 2001). If everything is found out right, the additives get approval. But none of the organizations can be 100% sure about lifetime safety. So, the safety check of the food additives after approval will also held on a regular basis. In some cases, a post-approval hearing is also requested. Public debate and discussion may ban the use of controversial additives (Rulis and Levitt 2009). After the additives get approval, the organization lists out the type of the food in which the additives can be used, and the labelling of the additives will also regulate (Jim Schonrock, Sean Sands et al. 2008). The European Union has strict rules, regulations, and approval systems when it comes to food additives to ensure the consumer's health and safety. It published the list of the commonly used additives as well as

the additives which include generally regarded as a safe (GRAS) ingredient, which is usually known as E number, and the clear labelling of the E number is necessary before the product goes into the market (Sofia C. Lourenco, Margarida Moldao-Martins et al. 2019). Any new additives must be authorized before the marketing and using in a food products. Different additives have been added to perform the specific function in the food and more than 2500 kinds of additives are available in today's market. Preservatives are one of the additives used in the food industry widely (A. Larry Branen, P. Michael davidson et al. 2001).

1.7. Aims and Objectives:

The aim of this study is to examine the utilization of potato peel as a source of natural antioxidants and to determine its market and possible opportunity. Specific objectives of this study are as follows:

- Market segmentation of natural antioxidant
- To develop a sustainable business model and market entry strategy for natural antioxidants from potato peel
- Challenges on regulatory approval for food additives
- Understand the competitive forces

2. Methods:

The data required for the thesis was collected by secondary data collection methods, whereas different business tools were also used in order for the completion of this thesis. Data were collected through various articles, the company's website, journals, books, and scientific papers with the help of numerous search engines such as google scholar, PubMed, Science direct, etc.

Business tools are all the methods, applications, controls, and solutions used by the individual company in their business for the detection and maintenance of the competitive position, for market analysis and to improve the performance of the company and add value to their products and services. In addition, it is used to describe and communicate the business ideas inside the company (Athanasopoulou and De Reuver 2020). For the completion of this thesis, the following tools and analysis methods are used:

2.1. Market segmentation:

The concept of market segmentation was first put forward by Wendell. R. Smith, in 1950s. Market segmentation is the method of dividing the broad customers into small and approachable homogeneous groups on a different basis so that each segment has similarities. Market segmentation helps to reach each customer and satisfy their needs more effectively. Market segmentation is an effective tool for marketing, product development, and for market entry because it defines customer needs and wants more accurately. Similarly, it helps to find market opportunities (Sun 2009). Market segmentation helps to identify multiple potential market opportunities. Segmenting a viable market helps select the best market among numerous market segments. By doing market segmentation, the company can give its 100%-time, budget, and effort on one best segments, technically saying, it helps in the selection of beachhead market and further analysis of the company. The single product produced by one company will have different end users depending upon the market segment. Every end user will use the product differently and get variable benefits. Every segmented market should be measurable and accessible.

2.2. SWOT analysis:

SWOT analysis is the second most frequently used analytical tool that has been in use since 1960s. SWOT analysis tool helps in acknowledging the internal factors, strengths, and weaknesses of the company as well as external factors, opportunities, and threats that can influence the business. It helps the company to use its strength and improve on its weakness, take the chances in case of opportunities, and make aware of the risks and threats that the company may come across. SWOT is primarily useful for analyzing and positioning an organization's environment and resources. After identifying the points of four fields in SWOT analysis, the organization can recognize its core competencies for decision making, planning, and building strategies (Phadermrod, Crowder et al. 2019).

2.3. Business model canvas:

Osterwalder's business model canvas was developed and further clarified by Osterwalder and Pigneur in 2010 by creating nine building blocks: value proposition, key activities, key partners, key resources, customer segments, channels, customer relationship, cost structure, and revenue stream. Osterwalder's business model canvas helps the company to plan the value creation and value delivery process and map its organization along a strong value creating function and activity. Simply saying, it is a visual snapshot of identifying the main elements of the business and relating them with each other. It also helps in the communication between the owner and its stakeholder (McFarlane 2017).

2.4. Porter's five forces:

Harvard Business School professor Michale E. Porter designed a business model to measure and understand the competitive factors and competitiveness that shape the structure of the business. This tool analyzes the connection between the competitive forces and profit potential in a specific industry. There is always an inverse relationship between the competitive forces and the profit potential in the industry. Porter's five forces aid to shape the success of the industry by preventing competition (Dr. Yogesh Hole, Pauer et al. 2019).

The five forces that shape the competition of the business are as follows:

- a) Rivalry among existing competitors
- b) Bargaining power of suppliers
- c) Bargaining power of buyers
- d) Threat of new entrants
- e) Threat of substitute products

3. Results:

3.1. Market segmentation:

The market segmentation for the potato peel antioxidant was done to distinguish and differentiate customers according to their similar needs and expectation, which makes it easy for product development, product differentiation, and marketing. In addition, it helps to understand the customer well and fulfill their need correctly. The potato peel antioxidant is divided into six different market segments, namely; food additives, packaging material, pharmaceutical and personal care products, fuel and lubricants, cosmetics and plastics, rubber and latex additives, and it is explained in detail according to its end users, its uses and its benefits to the end user (Table 1).

Table 1: Market segmentation of potato peel antioxidant

	Market segments	End users	Uses	Benefits	Market size (in 2021)
1.	Food additives	Vegetables and fruits preparing and packaging industries.	-For food preservation by extending the shelf life of fresh cut fruit and vegetables.	-Maintain the flavor, color, odor, and nutrition of the food (Javed, Ahmad et al. 2019) -Anti browning effect, slowdown of softening of fruits and vegetables (Venturi, Bartolini et al. 2019).	Global food additives market size USD 37.91 Billion (MarketDataForecast 2022).
		Vegetable oil producing company	-To enhance the stability of the vegetable oil effectively at all concentration.	-Upgrade hydrolytic stability by hindering thermal deterioration. -Higher efficiency as compared to synthetic one (Mohdaly, Sarhan et al. 2010) (Devi, Das et al. 2018).	

		Butchery, slaughterhouse, meat and fish processing, and packing plant.	-Alleviate the oxidation process of meat and toxic formation.	-Maintain texture, color, flavor, nutritional value, and meat safety.	
2.	Packaging materials	-Food including meat and fish producing, processing, and packaging companies.	-Addition of potato peel antioxidant into biodegradable protein-based films to make active packaging of smoked fish and food.	-Increase shelf life, and maintain the color, smell, and flavor of smoked fish (Lopes, Gonçalves et al. 2021). -Preserve the food without direct contact with the food; safer than petroleum plastic bags (Vera, Canellas et al. 2018).	Global packaging material market size USD 338.34 Billion (2021).
3.	Pharmaceutical and personal care products	Pharmaceutical manufacturing company	-People with diabetes type I and type II have increased lipid peroxides (LPO) production. PP antioxidant can be used to lower LPO and cure eye lens -To provide liver protection, Possibilities of cancer treatment (Ahsan Javed, Awais Ahmad et al. 2019).	-Lower glucose level in blood and cure eye lens damage associated with diabetics - Protect liver damage -Anti-carcinogenic effect (Ahsan Javed, Awais Ahmad et al. 2019).	Global pharmaceutical product market size USD 486.62 billion (2021).
4.	Fuel and lubricants	Fuel and biodiesel producing industries	To intensify stability by lessening oxidation which will increase shelf life, prevent micro-explosion and fire hazards.	Environmentally sustainable, convenient, promising source of the antioxidant which has the potential to replace the synthetic and non-renewable antioxidants (Devi, Das et al. 2018).	Global lubricant market size USD 130.03 billion (2021).

5.	Cosmetics	Cosmetics product manufacturing company	-Prevent the oxidative degradation, used to reduce the skin's oxidative stress.	- Stabilize the cosmetics product by preventing lipid oxidation, and increase the product's efficiency (Costa and Santos 2017).	Global cosmetics market size USD 80.74 billion (WRSD 2022).
6.	Plastics, rubber, and latex additives	Rubber, plastics, latex producing company	-The PP antioxidant is added to the plastics product	-Hinder degradation by thermomechanical or thermo oxidative condition -Increase the appearance, strength, and flexibility of the product -Prevent the loss of the mechanical property (BASF 2022)	Global plastics additives market size USD 51.04 Billion (FortuneBusinessInsights 2022)

The first market segment is food additives which is further subdivided into three different sub-categories. The primary use of the antioxidant in the segment is to maintain the flavor, nutritional value, color, and texture of the food and keep food safe for the consumer after consumption. The second market segment is the packaging material producing company, where the addition of the natural antioxidants results in the generation of the biodegradable packaging material, which helps in the replacement of the plastic packaging. The plastic free biodegradable packaging material has no health risk, and it helps to lower carbon footprint. In addition, the use of biodegradable packaging material helps to enhance the shelf life of the food and preserve food without direct contact with the food particle, which will lower the risk of contamination of the food. The third market is the pharmaceutical and personal care producing companies, where antioxidants reduce the risk of many kinds of diseases, including cancer, diabetes, and heart disease. The fourth segment is the fuel and biodiesel producing industry, where the company uses the antioxidant to enhance the resistance to oxidation, making fuel and biodiesel stable. In addition, it prevents the darkening and gum formation of petrol and biodiesel. The fifth market segment is cosmetics, where the antioxidant plays a vital role in the protection of the skin by hindering the effects of oxidative damage. The final market segment is the rubber, plastics, and latex producing company which will add antioxidants to its products to decrease the oxidation mechanism to build the product robust, flexible, and durable.

Pharmaceutical products have the largest market size (USD 486.62 Billion), followed by the packaging material market (USD 338.34 Billion). In general, all of the above markets have considerable market size. According to (Marc J. Melitz and Ottaviano 2008), the larger the market size, the tougher will be competitiveness. It concludes that all of the above market segments presented in Table 1 have high competition, but the pharmaceutical market has the most elevated competition.

3.2. Beachhead market selection:

The selection of one market among the six different markets from market segmentation is vital for the company to establish a strong market position, keep focusing on the critical area, and create positive cash flow in the company. Table 1 demonstrates the comparison of the three markets, namely, cosmetic, pharmaceutical, and food industries, based on CAGR, market size, and competition.

Table 2: Comparison of cosmetic, pharmaceutical and food industry by market size, CAGR, and competition

Market segment → Criteria ↓	Cosmetics industry (By 2028)	Pharmaceutical industry (By 2028)	Food additives industry (by 2028)
Compound annual growth rate (CAGR)	7.14%	11.32%	5.5%
Market size	USD 805.61 Billion	USD 832.11 Billion	USD 150.48 Billion
Competition	High competition	High competition	Low competition

According to Table 2, the pharmaceutical industry is predicted to have the highest CAGR (11.32%) (PRNewswire 2022), followed by the cosmetics industry (7.14%) (TheExpressWire 2022), followed by the food additives industry (5.5%) (MarketDataForecast 2022) over six-year time period. The higher CAGR will be the choice for the better investment by comparing returns over a time. In addition to the CAGR, the pharmaceutical industry is expected to have the highest market size, followed by the cosmetics industry followed by food additives industry by 2028. The market with a big market size will be the 1st choice due to the better market opportunity, more sales, high availability of raw materials and higher number of customers.

Competition in the market is another essential criterion to consider before selecting the beachhead market. Usually, the market size and rivalry in the industry are directly proportional to each other. The sector with a large market size will be more rival because of the access to the wide range of the products, services, and raw materials with the high customer number. Higher competition leads to decrease the market share and share the available customer as a disadvantage. So, by considering the comparable lower competition, considerable CAGR, and market size, the food additives market is selected as a beachhead market.

The food additives market will also be too large market for the star up potato peel antioxidant company with a limited budget and fewer human resources. There is a strong demand for effective preservatives in the fish industry compared to other food industries. Some of the main reasons behind it are 1) high microbial growth in fish meat compared to other food and meat products (either from contamination or from natural microorganisms present in fish). 2) The soft texture of fish also creates difficulties for its preservation, which impact the overall marketing of the fish. 3) High amount of unsaturated lipids and high protein content leads to rapid oxidation compared to other food particles. 4) During post harvesting process, the decomposition of the valuable component of the fish and formation of harmful compounds occurs, resulting in the degradation of the protein, oxidation of the lipid, and change in the odor, flavor, and texture of the fish. Some techniques for preserving the fish are common, such as cooled and store in ice flake, refrigerate, or preserve in ice slurry or by the chemical treatment, but they have either side effects or not compelling enough. Growing customer awareness towards synthetic preservatives and their harmful impact on customer health prompted the fish industries to search for natural products as an alternative (Mei, Ma et al. 2019). Salmon farming and exporting is one of the leading business and source of the economy of Norway. Norway produces approximately 1.2 million tons of salmon annually. It is largest salmon producer and

exporter globally (Hindar), and it always seeks an excellent antioxidant to preserve its salmon while transporting to other countries. Potato peel antioxidant can be a perfect solution for all of the problems for salmon industries as it has antimicrobial properties and preservation properties. In addition to this, it is natural and effective in a small amount. So, the value proposition of the product (potato peel antioxidant) strongly aligns with the market demand and customer's need. So, salmon producing, packaging, and exporting companies will be the profitable and suitable target market for this business. Further discussion and analysis will be based on the beachhead market (salmon producing, packaging, and exporting industry).

3.3. SWOT analysis:

SWOT analysis of the potato peel antioxidant was performed to acknowledge the internal factors (strength, weakness) and external factors (opportunities and threats) that acknowledge the business.

Table 3: SWOT analysis of potato peel antioxidant company

STRENGTH	WEAKNESS
<ul style="list-style-type: none"> - Freedom to operate (no patent granted yet) - Able to alter the direction quickly if needed - Can file a patent - Greener business model (competitive advantages) - Cheap raw material and easy access to raw material - High quality pure natural product with no side effects 	<ul style="list-style-type: none"> - No existing reputation, brand, and market presence - Small team and company with a limited budget - Unreliable cash flow in the early stage - No prior working experience of the company - Lack of skilled manpower in every field in the team
OPPORTUNITIES	THREAT
<ul style="list-style-type: none"> - Increasing demand in domestic and international antioxidant market - High governmental support & customer preference toward natural product - Growing market with a market size value \$4.14 billion in 2022 and 6.9% CAGR from 2022- 2031 is expected (Raju Kale and Deshmukh 2022). - Media coverage and promotion for the green products and green process - Increasing interest of the public sector, consumer and government towards nature conservation, waste management, circular bioeconomy 	<ul style="list-style-type: none"> - Competitors and numerous substitute products - Need a regulatory requirements and approval - Market and society acceptance in real is still not clear - Spread awareness through word of mouth is hard - High taxes rate in Norway

As presented in table 3, the potato peel antioxidant producing company's key strength is that the concept is new in the market (even though there are already some natural antioxidants in the market, the potato peel antioxidant is rare in market). So, there will be freedom to operate, and the company can file a patent. In addition, the company's core concept is ecofriendly antioxidant production by utilizing the waste potato peel from the different food industries. It helps in the waste management, promotes recycling and reusing concept, and focuses on the circular bioeconomy of the potato peel, which is the significant competitive advantages of this company. The positive environmental influence of the company is a great topic of concern and the most vital factor of acceptance in modern society. Another ability of the company is that the company can quickly alter the direction if the target market seems not profitable, or other uncertain things happen during product development. The company can either change direction by starting to produce a whole product or changing the target market. The major weakness is, the company is small with less budget and manpower, which is challenging for the company. Moreover, there will be no brand and reputation of the company as it is an entirely new company.

The important opportunity is the increasing public and governmental concerns about the natural product, which flourish the market demand. Similarly, known adverse health effects of synthetic antioxidant tend to grow the market for natural antioxidant. The antioxidant market is growing, and it is expected to grow more in the future, and the concerns of media, government, public, and organizations towards the adverse health effect of the synthetic antioxidants on the consumer health is a very good opportunity for the potato peel antioxidant company. The potential threat is that there are already existing substitute products and established companies in the market, which can create a challenging situation for the small start-up company for the market entry and establishment. The company can cope with this situation either by cost advantages or by differentiation advantages (Christensen 2001). As a small startup company, cost advantage (low-cost product) is not possible for potato peel antioxidant company. So, the company must focus on differentiating it from competitors by creating a high-value product for the customers. The company with a greener business model that produces eco-friendly natural products with no side-effect makes it unique compared to its competitors. The high-quality natural product with high efficiency is the central attraction point to the customer. Additionally, regulatory approvals are a costly and time-consuming process. Until one company gets regulatory approval, another competitor company can take over the business by launching the same product in the market before the original company does. So,

the company should think about the time limit while developing and marketing of the product. There is no proof in the market showing that the potato peel antioxidant can act as a good preservative, and it's hard for the customer to accept and believe the product. And the additional difficulty is the establishment of a business in Norway because it has a higher tax rate and stringent rules and regulations compared to other countries.

3.4. Osterwalder's business model canvas:

Table 4 represents the business model canvas for the potato peel antioxidant company, which visualizes how the potato peel company creates, delivers, and captures value to its customers. The business model canvas of the company is represented in nine different building blocks, which describes the four crucial area of the business i.e., customer segment, supply chain, infrastructure, and financial situation of the company. In order to obtain the business model canvas of the potato peel antioxidant company, the selected beach head market (salmon producing, packaging, and exporting industry) was analyzed along with various factors around the company. What value the salmon industry will get, how the potato peel antioxidant makes money, the company's expenditure, how the company contact with salmon industries, and how it delivers the product to its customers are analyzed.

Table 4: Business model canvas for potato peel antioxidant as a food additive:

KEY PARTNERS	KEY ACTIVITIES	VALUE PROPOSITION	CUSTOMER RELATIONSHIP	CUSTOMER SEGMENTS
1) Suppliers of raw material (chips factories) 2) Laboratory technicians for the extraction of the antioxidant 3) Investors, shareholders, commercial banks 4) Marketing, advertising, and distribution network 5) Finance and IT	1) Extraction, production, and purification of antioxidant 2) R & D 3) Product testing 4) Quality control 5) Branding, packaging, distribution, and marketing 6) Customer service	1) Highly reliable, innovative company 2) High quality product and services (pure natural products) 3) High performance, effectiveness, and highly stable product with no toxicity and less allergic to user 4) Quick and efficient supply inside Norway	1) Phone calls 2) Email 3) Company's website 4) After sales chatbot to track customer satisfaction	1) Small to medium salmon producing, packaging, and exporting companies located in Norway
COST STRUCTURE		REVENUE STREAM(S)		
1) Advertisement 2) Marketing and distribution cost of antioxidants produced inside the lab 3) Cost required for the extraction of the antioxidant from potato peel, equipment cost 4) Raw materials (potato peel waste from several food industries such as potato chips, French fries' industry, crisp) 5) R & D and patent 7) Interest in bank		1) Sales of purified antioxidant as a food additive for salmon producing, packaging and exporting companies		

Designed by:

INN student

Designed for:

Potato peel
antioxidant for the
salmon industry

Date:

25th April 2022

The principal value proposition of the company is that it is an innovative, research-based company that produces natural antioxidant in the market. This company produces antioxidant of higher quality, efficiency, and stability, which gives high value to the salmon industry for the preservation. The customer for this business is small to medium salmon farming, packaging, and exporting companies located inside Norway. The channels through which the company reaches its customer are the company's website, phone calls, and advertisement. The major resources required for the company to deliver its value are physical assets, financial assets, R & D, patent, and skilled manpower in the required field. Similarly, the relationship with the customers can be maintained by phone, emails, and tracking of the customer satisfaction after sales. The start-up company generally requires numerous partners. Some of the necessary partners for the potato peel antioxidant company are raw material suppliers, a scientist for the antioxidant extraction, investors. Furthermore, marketing, advertising, and delivery partner is also a key partner for this company. The main revenue source of the company is the sales of natural antioxidant. The major costs that business occurs through its operation are patent fee, equipment and raw material cost, R & D, and advertising cost.

3.5. Porter's five forces for the potato peel antioxidant:

The Porter's five forces method is used to investigate the five different competitive forces around the potato peel antioxidant company that shapes the business. The five forces are used to quantify the intensity of the competitiveness, attractiveness, and profitability of the antioxidant market. The five forces are as follows:

A) Rivalry among existing competitors:

Although the potato peel antioxidant business is not so popular business until today, there are already existing natural antioxidant and synthetic antioxidant producers in the market, which creates intense rivalry among the competitors. Some of the essential elements needs to analyse the rivalry among the existing competitors are as follows:

- Number of competitors: There are numerous antioxidants available in the current situation, and it has been already more than half a century since the 1st natural antioxidant was patented. The natural antioxidant is not the only competitor for the potato peel antioxidant, but also synthetic antioxidant producer are also the competitors for the potato peel antioxidant. Some of the competitor companies for potato peel

antioxidant are BTSA, Minirito, Oxiris, Polyphenols AS, Conagen, Laboratorie Nutergia, Red Ruby Food Trade Ltd., Beijing Jiyi Chemical industry, BIOBRAINE, EVESA, etc.

- Growth rate of the industry: The CAGR of the antioxidant market is growing, and it is predicted to reach 6.9% over the nine-year time from now. The increasing population, increasing health concerns, and low waste production concept are the major factors that enhance the growth rate of natural antioxidant.
- Switching cost: The switching cost for the customer is low because there is no equipment cost, no installation cost, and no learning cost in the antioxidant market.
- Loyalty of customer: The customer's commitment towards an already established company in the market is one of the major challenges for the start-up business.

B) Threat of new entrant:

There is always a risk of new competitors in every business. This means that when the new company starts selling the same or similar product or services as an existing company, the threat to the existing company in the market will increase. The new entrant in the market will reduce the market price and lower the market share. Some of the essential elements need to analyse to identify the threat of new entrants are as follows:

- Economy of scale: The economy of scale largely depends upon the volume of the production by the company. Larger volume of the production reduces the costs per unit of the product. This scenario will be harsh to the start-up company because the production volume of the start-up company is usually less. To remain competitive in the market in this situation, either the company can take the risk of price disadvantages over the large companies, or the company must take the risk by producing larger volume. For potato peel antioxidant also, it will be tough to compete with an already established company.
- Time and cost to entry: Mostly, biotechnological innovation requires high R & D time and a huge budget. The potato peel antioxidant industry should invest huge money in IPR, patenting, R & D process, and for regulatory approval, etc.
- Barriers to entry: The antioxidant market requires regulatory approval, which needs huge cost and time. It requires a high amount of money for R & D as well. The patent by the competitor company will also create a high barrier to entry in the market, but there is no approved patent found for the potato peel antioxidant till today. So, the barrier to entry for the potato peel antioxidant market can be considered as medium.

C) Threat of substitute product:

In every business, there will be some extent of the threat of the substitute product. A substitute product tries to solve the same or similar need of the customers by using different technology, which directly shrinks the pie of the individual business in the market. Some of the essential elements needs to analyse to identify the threat of substitute products are as follows:

- **Cost of switching:** The switching cost will be inversely proportional to the threat of substitutes. There will be low switching cost in the antioxidant market, so the threat of shifting the customer towards the substitute product will be high.
- **Performance and price of the product:** The cost of the product largely depends upon the quality of the product. As the raw material for the potato peel business is the waste material, the produced antioxidant will be reasonable in terms of price. There are customer trends towards using the natural product and increasing awareness towards circular economy, which will be a plus point for the natural antioxidant producer. And the existing side effect of the synthetic antioxidant increases the customer's concerns about natural one. And this can be considered as a positive point for the potato peel antioxidant market.
- **Number of substitute products in the market:** Several kinds of substitute products range from natural to synthetic, available in the market recently.

D) Bargaining power of suppliers:

Supplier's bargaining power means the pressure created by the suppliers to the manufacturer company by increasing the price (raw materials price, price of chemical, price of necessary equipment), by lowering the quality and availability of the product, which will influence the competitive environment and profit potential of the buyer. Some of the essential elements needs to analyse to figure out the bargaining power of suppliers are as follows:

- **Number of suppliers:** Some companies have started to supply the skin of animals, fruit, and vegetables to other industries in the world. There are a few suppliers of potato peel also in various forms (dried, frozen, fresh, or powder form) in some countries. Nowadays, some peeled potato suppliers in the market can be the supplier of the raw material to the potato peel antioxidant industry. But this company can directly contact to the chips and fries manufacturer company inside Norway. Short distance raw material

as possible will be beneficial than having raw material supplier in other countries. Additionally, team up with the chips, fries manufacturer company helps to find raw material in cheap price because for chips industry, the potato peel is a zero value waste product.

- Supplier switching cost: The supplier switching cost of the antioxidant market is not so high.

E) Bargaining power of customer:

The customer's bargaining power is the pressure created by the buyer or customer towards the manufacturer's company. The bargaining power of the customer depends upon the number of manufacturer companies. The buyer's power will increase if many alternatives are available in the market. There is always a threat of buyers switching from one product to another product. Some of the essential elements needs to analyse to identify the bargaining power of customers are as follows:

- Buyer switching cost: The switching cost of the buyer is low as the customer is not buying some types of machinery or instrument. So, the customers can simply shift to another antioxidant producer.
- Customer interest in the product: The customer of the potato peel antioxidant company is a salmon business located in Norway. Even though the potato peel antioxidant is a new concept in the market, higher competitive advantages over its competitors attracts customers towards it. The media coverage and governmental support for the green product, circular bioeconomy, and profitable waste management help to increase the customer's interest towards it (Asthana, Jones et al. 2019).

4. Discussion:

Antioxidant have been considered a very important material since past centuries. They can be natural and synthetic. Natural antioxidants are those which are acquired absolutely from natural sources. Some examples are Polyphenols (Phenolic acid, flavonoids, anthocyanins), carotenoids, vitamins, etc. Antioxidants obtained from the chemical process are generally recognized as synthetic antioxidants. Some examples of synthetic antioxidants are Butylated hydroxyanisole (BHA), Butylated hydroxytoluene (BHT), and Propyl gallate (PG) (Mahmoud, Wilkinson et al. 2021). Different theories and methods have been used since past to produce or extract the antioxidant from botanical species. The use of synthetic antioxidant was high compared to the natural antioxidant in the past because synthetic antioxidant has good performance, stability, high availability, and low production cost. But the safety issue, long-term side effects, and carcinogenic effects have pulled the synthetic antioxidant into the topic of controversy since few years. After the harmful impact of the synthetic antioxidant was proved by further research, the pressure was created to find some natural alternative. Additionally, it shifts the customer preference from synthetic antioxidants to the natural antioxidant. In nature, numerous components can be found that can prevent oxidation, but only the food grade antioxidant, which is GRAS compound, will get regulatory approvals for use (Lourenco, Moldao-Martins et al. 2019). Food is essential for life, and food safety is a concerning topic among people and food companies. Food antioxidant plays a vital role in the food industry as it is useful to preserve food by preventing the change in the taste, odor, and color of the food through autoxidation and lipid peroxidation process (Carocho, Morales et al. 2018). The oxidation of fats and oils causes a bad odor and taste to the food, which leads to lower the nutritional value by the formation of the secondary compound, which can be toxic to the consumers (Weshahy and Rao 2012).

Certain plants have been recognized as a rich source of polyphenol which can be used as an antioxidant. The importance of antioxidant in the foodstuff, health sector, and pharmaceutical products have been recognized widely. The antioxidant deficiency leads to oxidative changes by generating reactive oxygen species and free radicals. The formation of such kind of product will be harmful to the original substance in the sense of decreasing quality, lower nutritional value, altering the taste, odor, color, texture, smell, and reduced safety of the particle (Michael Antolovich, Paul D. Prenzler et al. 2002). Potato is the most common food, grow in most of the

countries in the world, and its production and consumption are increasing worldwide. The waste (potato peel) after the production of the main product (French fries, mashed potato, peeled potato) contains a huge amount of phenolic compound compared to potato flesh. So, the potato peel can be utilized to produce the high value product. The potato peel has antioxidant, antidiabetic, antitumoral, anti-inflammatory, and antibacterial properties. The antioxidant can be extracted and used to prevent the oxidative reaction in numerous products. So, the market potential for the potato peel antioxidant was analyzed for a profitable and successful market entry strategy and suggested the beachhead market for the business. Different business tools are used for the compilation of this thesis.

The development of the company based on the idea of the extraction of the antioxidant from the potato peel helps the customer to replace the harmful synthetic antioxidant with the naturally produced antioxidant (which has no side effects for the consumer). This concept will also promote the sales of the end user company due to the high customer preference for the natural product over the synthetic one. Not only the benefits of the customer health, but this concept will also give a positive impression as regards the environmental aspect. It helps to promote the recycling and reusing concept, circular bioeconomy of the potato peel, and supports the greener business concept. The companies and the customers who supports a healthier environment and good health will obviously choose this company over its competitors. The recovery of the highly valuable phenolics from PPW can improve the economics of the potato processing industries as well as the economy of the government. The reason why processing industries have attempts to reuse the by-product is not only environmental aspect but also due to the huge economic losses as there will be a high quantity of the by-product produced as a waste product after extraction/ production of the main product (Lourenco, Moldao-Martins et al. 2019). Not only the potato peel waste but numbers of plant and fruit waste are reuses to produce functional food with added value, which eventually promotes the use of natural antioxidant over synthetic one. Some examples are; the use of phenolic compound present in an olive leaf to prepare bioactive packaging, the skin of litchi fruit as a source of phenolic compound in cooked nuggets, green tea extract as a source of polyphenols for the preservation of the sunflower oil, use of apple peel as a source of the phenolic compound for the preservation of the tomato juice, use of mint extract as a phenolic compound for the preservation of the pork salami, use of rosemary extract as a source of phenolic compound for the preservation of the oil (Lourenco, Moldao-Martins et al. 2019).

4.1. Regulatory approval of food additives:

The use of preservative as a food additive plays a vital role in the preservation of food and less food waste production in today's high demand food supply chain. Food additives extend shelf life and maintain the good food quality. The food additives help to provide safer and more nutritious food for the consumers. It also provides greater choice of food (preserve food for out-of-season) with reasonable price to the end users. There are some direct and indirect disadvantages of the food additives. Hypersensitivity reaction on sensitive individual even though the additives are used in legally accepted levels is one of the possible risks of the food additives. The problem of the hypersensitivity reaction can be lower by the proper labeling to avoid the potential allergens (A. Larry Branen, P. Michael davidson et al. 2001)

In European country, the European Food Safety Authority (EFSA) is the responsible organization for ensuring the safety and the approval of the food additives. The approval process of the food additives contains several steps, starting with the search for the toxicological data in previous research in living beings. From this observation, the no-observed-adverse-effect level (NOAEL) will observe, which means additives with no adverse effect and toxicity levels are monitored. Then the amount of food additives consume in daily life without any health effect is calculated, which is called acceptable daily intake (ADI). It is analyzed with the help of NOAEL for the different food additives. EFSA also has criteria for purity, labeling, daily intake dose, and maximum level of use. The clear labeling of the food additives is also required to get approval. The E number and the performance of the additives in food must be labeled adequately. The proper labeling of the food additives also helps to prevent the accidental allergic reaction. If the consumer is allergic to some food particle, the consumer reads the labeling carefully and readily avoids that food (A. Larry Branen, P. Michael davidson et al. 2001). Strict regulation is required for the approval and use of food additives as it is directly linked with the health of the population. The use of the additives more than the limit in an excessive manner and the use of the non-approved or illegal substances as a food additive to enhance the companies' profit direct the users to think that the addition of the foreign substance to the food particle is harmful. Generally saying, the addition of synthetic additives or preservatives to the food leads to adverse health effects. So, the preference for natural antioxidant is increasing rapidly, and the population widely accepts them for better health and safety.

4.2. Choice of suitable target market:

Market segmentation for potato peel antioxidant was done based on different type of end users, uses, and benefits. A potato peel antioxidant company needs to gain sufficient knowledge about each possible market segment before entering into a particular market. Because the company is small with a limited budget, manpower, and the concept is new in the market. So, the company cannot target several markets at a time. The primary potential market for potato peel antioxidant includes the food additives market, packaging material producer, pharmaceutical and personal care market, fuel and lubricant market, cosmetics market, plastics, rubber, and latex additives market. As food additives is also a huge market, it was further segmented into a different kind of food producing industries. Among these markets, the selection of the one suitable market is vital. The choice of the target market should be suitable for the company in terms of its budget, workforce and time available. Among six potential market segments, three important markets were selected for further analysis in terms of the growth rate of the market, size of the market, and competition. The pharmaceutical market is expected to have a higher compound annual growth rate in comparison. Generally, 5-10% of the CAGR is considered good for the industry (Stockopedia 2022). So, all of the markets are good in terms of CAGR. Additionally, CAGR analysis is vital because investors always want to know the demand for the product in the market over a certain period before investing.

Second most crucial criterion needed to be analyzed for the selection of the beachhead market is the size of the market. Market size analysis is vital for a new business to develop a solid marketing and good market entry strategy. Typically, a larger market will have higher productivity, higher product variations, high sales, higher number of consumers, which can be considered as a benefit for the business. The market size and competition are always linked with each other. The larger the market size, the higher will be the competition (Marc J. Melitz and Ottaviano 2008). The competition will have both positive and negative effects on the business. On the one hand, the competitive situation accompanies a lowering the market share and division of the potential customers as customers will have more options available. The competitive situation forces the company to lower prices, eventually reducing the profit margin. On the other hand, the pressure created by the competitors encourages the company to promote quality, product variation, and easy access to raw materials. Moreover, competitiveness in the market helps the company being more innovative. But as a small startup potato peel antioxidant

company, the disadvantages of the competitors outweigh the advantages. So, the food additives industry, with less competition will be a suitable target market.

The food industry also became very large for the potato peel antioxidant company. So, further analysis was done for the selection of the suitable target market for market entry. The target market should not be too big so that the company cannot fulfill customer's needs and cannot reach every customer. Also, the target market should not be too small, so that it will be difficult to get enough customers and profit. Norway produces approximately 1.2 million tons of salmon annually. Norway is the largest salmon producer in the World (Hindar). Norway exports salmon to many countries, namely, Poland, France, Denmark, the United States, Netherland, Spain, Italy, the United Kingdom, Germany, Japan, etc. So, the Norwegian salmon producing, packaging, and exporting industry always seeks an excellent preservative to preserve its salmon while transporting salmon from Norway to another country. Fish is more vulnerable for the contamination by different kind of microorganism. So very effective preservative is necessary to preserve the fish. Soft skin of salmon makes it more difficult for the preservation and transportation. So, the salmon industry has a great value of natural preservative as compared to other customer segments (since huge quantity of salmon is exported, it requires reasonable and effective antioxidant in large quantities). Salmon packaging and exporting business can get excellent value proposition from the potato peel antioxidant. If the company succeeds in the salmon segment, it would be much easier to launch the product in the other segments. This will prevent the requirement of a huge budget at the company's starting phase and avoid uncertain losses. As the salmon producer companies always seek something in which they can trust for the salmon protection, it will be easy to sell to this customer group. The number of the salmon business is also increasing in Norway day by day, so the market demand for antioxidants is also increasing.

4.3. Competitive analysis:

The potato peel antioxidant company has some direct competitors (company selling natural antioxidant) and indirect competitors (synthetic antioxidant producers). The competitive analysis of this company was done by using two business tools, namely, SWOT analysis and porter's five forces.

4.3.1. Analysis of SWOT table:

The SWOT of potato peel antioxidant company helps to determine internal as well as external factors affecting the company. It helps to figure out the area where the potato peel antioxidant company is good so that the company can give more focus to maintaining and strengthen its strength and what the company lacks so that the company can think about some improvements, utilize the available opportunity, and make the antioxidant company aware to the possible risks that may arise in upcoming future. There is the freedom to operate, and the company can file a patent, which is the company's primary strength. The patent file can prevent direct competitors come across through same ideas, and the patent royalty can be a source of income for the company. The company's idea is based on the concept of recycling, and it is environmentally friendly, which will be the main attraction point for the customer and competitive advantage for the competitors. The company can produce high quality, pure, natural product which is strong strength of the company to overcome competition and attract customers towards it. Another strength of the company is that the raw material required for the production is potato peel which is cheap as the potato peel is a zero-value waste by-product of chips manufacturing industries. It has been used either as a fertilizer or as a feed for the animals. Usually, potatoes can grow in all seasons, and the productivity will be high in cold weather. So, the raw material can be found in Norway throughout the year.

Limited funds, limited number of the expertise, lack of reputation and brand are the weakness of the company. The company can present its business model with business idea to the investor after the patent approval to collect funds. Because it is risky to expose the companies' ideas to anyone before patenting the idea or technology as the concept can be copied. The company can apply the business fund in the commercial bank to solve the financial issue. But still, there are a few things to remember- 1) the company should pay interest in the bank for the commercial loan, which will be added to the cost structure of the company 2) the company should share its pie with the investor, and the company cannot do everything that it wants because the investor will also have some power to the company (according to the agreement between the company and investor, and according to the share invested by the investor in the company). The company will cope with the lack of reputation and branding by partnering with another renowned marketing, distribution, and advertising company so the potato peel antioxidant company can quickly gain popularity in the market due to the reputation of its partner.

The opportunities are growing market, increasing market demand, increasing awareness and preference towards natural products. Furthermore, governmental concerns and support for recycling, reusing, and circular bioeconomy is the great opportunity for this company. The Norwegian government is always careful about environmental issues. It always supports the business that will promote the environment. The governmental support and promotion of the product is a huge opportunity for the company. Additionally, the market for antioxidants is growing and is predicted to grow in the future, which proves there is a demand for antioxidant in the market. So, antioxidant can be considered a profitable and demanding business. In the current situation, people are aware of their diet, the food composition, preservatives used in the food, and consumer's preference towards the natural product is growing enormously. The customer preference for natural products over synthetic products can be considered as very huge opportunity for this business (Augustyniak, Bartosz et al. 2010).

Whereas the major complication to establish this business is a lengthy and costly regulatory approval and existing substitute products in the market. Substitute product creates the startup company difficult situation to compete and gain market share because the substitute product has already won the market, customer loyalty, and established brand. It is challenging for the new company to attract/ win the loyal customer of another company. But the potato peel antioxidant has a strong value proposition, which can be used as a weapon to overcome these challenges. Most biotechnological innovation has to go through a costly and protracted regulatory approval process. There will always be risk that another company can also come through the same idea during that lengthy approval process. So, the time frame is so essential in business, especially for that innovation that requires a huge budget and time for R & D. As the company does not have any reputation in the market yet, the advertisement through word of mouth is weak for this business. This is important to remember customer is a very good advertiser. Finally, the establishment of the company in Norway is comparably hard as Norway has stringent rules and regulations that should follow, and the tax rate of Norway is higher as compared to other countries.

4.3.2. Analysis of Porter's five forces:

Porter's five forces analyze and evaluate the five competitive forces for the determination of the competitiveness of the potato peel antioxidant company. This framework is useful to understand the company's competitive position and the strength of the position that the

company may achieve. From Porter's five forces of potato peel antioxidant, the rivalry among existing competitors was analyzed high. The increasing CAGR of the industry indicates that the demand for the product and services will also be increasing. According to (Stockopedia 2022), 6.9% compound annual growth rate of the antioxidant market over nine year time period is attractive. The first patent for the extraction of the antioxidant from the natural resources was filed in 1940 and it got approval in 1943 (Company 1943). So, it has been more than 80 years since the 1st antioxidant from natural sources was patented. On this basis, it can clearly say that there are many natural antioxidants on the market till now. Laboratoire Nutergia is one of the competitor companies located in France, have more than 200 employees, whose primary focus is in the health nutrient sector by producing various dietary nutrients along with antioxidants, antioxidants for food supplements. It is a leading antioxidant supplier internationally. Similarly, Red Ruby Food Trade. Ltd. is 1st established in 2018, and it is a major producer and supplier company of saffron, saffron tea, and other product from saffron and food supplements. It has several branches and distributorships in many countries. Saffron and its products are popular among companies because of its antioxidant activity. Beijing Jiyi Chemical Industry, located in China, is the largest domestic manufacturer of antioxidant and chemical fertilizers with more than 500 employees. Another competitor company is BIOBRAINE, which is located in Belgium, and mainly works in the field of organic food, healthy and natural food, food additives, antioxidants and food supplements. Extractos Vegetales, S.A. (EVESA) is a company founded in 1972 in Spain that mainly focuses on the natural product production from natural herbs and species for the food industry, pharmaceutical industry, and perfume industry. It produces natural antioxidants from rosemary extract.

The loyalty of the customer is important in every business, but it can be considered as a threat or problem for the new and start up business. People who use products from another brand are not willing to change the brand or product unless the new product is better than the existing one. So, customer loyalty towards the existing antioxidant producer will be one problem for the potato peel antioxidant company as it has no existing customers. High number of competitors, high loyalty of the customers towards the existing company and its product, and high CAGR make the antioxidant market more rival. There are so many natural and synthetic antioxidant producers. The threat of new entrant for the potato peel antioxidant is relatively low due to the higher barrier to entry. The new company requires several regulatory approvals, which are pretty expensive and time consuming. The biotechnological innovation requires long research and development time, and cost such as infrastructure, equipment, a chemical required,

raw material, and salaries also added to the budget. It seems tough for the potato peel antioxidant to compete with the already established large competitors. As being a startup, the company cannot produce tremendous amount of antioxidant at the beginning which will increase the production cost per unit of the product. So, the company either has to lower the price of the product from its profit margin, or the company cannot be competitive in the market in terms of price as a larger company can offer its product at a lower price.

The threat of the substitute product is analyzed high because the number of substitute products is high in the market, which will lower the company's market share. But the strong competitive advantages of the company help the company to remain competitive, and the strong value proposition helps to win customer. As the antioxidant does not require any installation, machine, or special thing where the customer has to invest huge money, the switching cost is very low. If the customer wants, they can simply shift from one product to another. Customers have to stay with one brand if the switching cost is high. But in the potato peel antioxidant case, it is considerably low. The bargaining power of suppliers is another factor to measure the competitiveness of the company. The primary factor to determine the bargaining power of the supplier is the number of suppliers in the market. As some companies start to supply potato peel and other fruit and vegetable skin, it is not so much famous around the world. So, relying on the supplier for the raw material may lead to high-cost raw material because the suppliers will get more power if the company has no other option for raw material. Potato peel is an easily available raw material. So, direct contact with the different food industries for the potato peel is the cheapest option. The bargaining power of the customer is high as there are number of substitute product, and competitors' companies are fulfilling the customer's need by producing substitute product. So, the customer will have high options, in this case, the strong value proposition is the only way to win a better profit margin.

4.4. [Business model canvas:](#)

The business model canvas of the potato peel antioxidant company presents the business plan in a single page that provides a quick overview of its nine key components which is most essential to think about before establishing a specific business.

Customer segment:

Table 4 indicates that the company is planning to enter in Norwegian market at the beginning. The salmon producers, packagers and exporter are the primary customer segment for this company. Norway is the largest salmon producer globally, and the market demand for salmon is increasing rapidly. In 2009, the production of salmon was 1.4 million tons in Norway (Thomas A. Larsen and asche 2011). The export of salmon is one of the major businesses in Norway. So, there is a huge demand for the preservatives to ensure the safety of the fish during transportation from Norway to other countries. At the beginning, a small to medium-sized company will be the target of the potato peel antioxidant company. After the company starts to make profit and starts the market penetration, it will be easy to expand the market with larger salmon producers and exporters. The company can add a new customer segment as well. The customers can order online directly through the company's website and pay by card. The customers can be considered a very important source of the advertisement. Directly or indirectly customers will promote the product (by word of mouth), helps to increase sales success, helps to create sustainable growth, and helps to attract new customers. But if the customers remain loyal to the existing brand, it will be challenging for the new company. So, the new company should develop better competitive advantages (in terms of price, product quality, and outcome after use) as compared to its competitor's company to cope with this problem and attract more customers and market share.

Value proposition:

The company is an innovative company that can fulfill the customer's needs and demand by R & D. The company will be able to make product variation, product differentiation, and increase production according to the market situation, and customer need in the upcoming future. The product is a high-quality natural product that is very effective even in a small amount. Additionally, the antioxidant does not react with other components present in the salmon, and it remains stable while processing, packaging, transporting, and storing. According to (Kobayashi, Nakamura et al. 2021), potato is less allergic to vegetables and potato allergy is very rare. Sometimes the preservative produced from different sources can cause an allergic reaction to the end user, but it's very low in the case of potatoes, which gives excellent value to the end user and antioxidant buyer company. Customers can rely on the potato peel antioxidant company as it is able to continuous and quick supply of the product in a short delivery time.

Key activities:

The major activity of the company is the extraction and purification of the high-quality antioxidant by R & D to the salmon producer and exporters. Quality control (QC) is the essential activities after the antioxidant production to ensure every batch of the production has the same (high) quality product. QC is necessary for the maintenance of the safety that can be implemented to be sure harmful product do not end up with customers. For every batch production, QC is necessary as the quality of the product may differ by some small factors such as quality of raw material, quality of the chemicals used, human error, and contamination. After the product passes the quality check, packing in proper condition is essential as the temperature, moisture, and humidity may lead to loss its property or efficiency. Another important activity of the potato peel company is branding which helps the company to create a strong position and reputation in the market. The establishment of a brand in the market is critical to win the loyalty of the customer. Branding gives meaning to the product or company, which will make impression in the customer's mind. This strategy helps the company to win its customers from competitors. Even though the product will be same, customer have trust towards the reputed brand. So, the product with popular brand will be the choice of the customer. Other activities that need to be done are distribution, marketing, and customer service. The reliable delivery on time makes the customer to buy antioxidants from same company time and again. Marketing and customer service are also necessary as tracking of customer preference, customer satisfaction, customer demand, and market demand help the company to remain innovative in the market.

Channels:

Channels generally refer to the means that the company uses to communicate and reach their target audience. For the potato peel antioxidant company, the channels will be virtual as it is planning to make just online sales at the beginning. The company's website is one of the major channels through which the communication and contact to the customers can done. Similarly, for recurring customers, the best way to contact them is direct phone calls or emails. Another accessible channel is the advertisement of the company and its product to the seminar, champion related to salmon where the entrepreneur gathers.

Key partners:

The company has no capabilities for extraction and marketing of the antioxidant on its own as it is a startup with a low budget. The fund management can be done by self-funding, investor,

and business loans. Finding an investor with experience working with a startup company is a good idea. The company can share its business idea with the potential investor. The investor will go through the documents of the company's management team, business plan, market, product, and services. If the investor wants to go ahead, the agreement will be made between two parties. But the granted patent is the most important thing before this step otherwise, the idea can be stolen. Another important strategy is to develop a partnership with another established and reputed marketing company. The conjunction of two companies (One company is export for the production and another company with experience in marketing, branding, and distribution) will double the company's strength. In addition, this partnership strategy aids in brand leverage, which will be more effective branding than developing the antioxidant company by their own. Similarly, the partnership helps in the fund management, guide in making important decision, and risk taking. Finding the right partner is vital. If the company still needs more funds, the business loan will always be available. The availability of laboratory expertise/scientists for the extraction of the antioxidant with innovative skills is one of the important human capital resources. For the continuous supply of antioxidant, reliable raw material suppliers are essential. Team up with a large potato processing industry inside Norway is an excellent way to get steady stream of raw material. There are numerous large potato processing industries located in Norway that will deliver their chips and fries worldwide. Those company produces potato peel in large quantities as a by-product. Some of the potential raw material (potato peel) suppliers are; Sørlandschips AS, Maarud AS (Zec), Viken Snacks AS, Kims, Kantefølflak, HOFF Norske Potetindustrier. This team up strategy helps the antioxidant company to get cheap raw material, and it will help the chips industry with the easy waste management and source of additional income. So, this team up will be profitable for both sides.

Cost structure:

Starting a new business requires high costs, can be categorized into startup costs, pre-opening costs, and post-opening costs. The major costs are research expenses (cost for R & D), patent fee and licensing, cost of regulatory approval, equipment and supplies cost, advertising, and promotion cost. In addition, it is beneficial for the company to prepare some extra funds for any unexpected expenses which may happen suddenly in the future.

Revenue stream:

The revenue is the money generated by the company by the previously defined customer group. The purpose of this stream is to check whether the stream is profitable or not. For this, willingness to pay, market price, and competitor's strategy is important to know. The major revenue stream of the potato peel antioxidant company is asset sale, means sales of the purified antioxidant, which is the most common practice in many companies.

5. Conclusions and Recommendations:

This research aimed to build a sustainable business model and to evaluate the suitable market entry strategy for the natural antioxidant produced by utilizing potato peel waste from different food industries. Food additives, packaging material industry, pharmaceutical, and personal care products, fuel and lubricants, cosmetics, and plastics, and latex additives industry were found as a major potential market for potato peel antioxidants. Small to medium salmon producing, processing, and exporting industry was chosen beachhead market because of the considerable number of salmon producers in Norway. In addition, soft skin texture and easy microbial contamination make salmon harder to preserve by other methods. So, the salmon industry gets good value from potato peel antioxidant. The best market entry strategy for the potato peel antioxidant company was analyzed as a partnership with another renowned company with prior experience in branding, marketing, and distribution because it boosts the strength of the company twice as well as helps the company in decision making and fund management. This study also suggest that patenting is vital to the company because it protects the invention from being stolen or copied by another company. The high number of competitors company, existing substitute product, loyalty of customer towards existing brand makes the antioxidant market more rival, but the strong value proposition (highly effective natural product) and competitive advantages (greener business model) was found to be powerful weapon to win the target market and competition for potato peel company. The potato peel antioxidant should be GRAS substance in order to get approval by European Food Safety Agency (all identified by an E number).

Recommendation and suggestions for further research:

- This study focused on the potato peel antioxidant company's feasible and profitable market entry strategy. There is a need to explore the possibilities of potential product production from the remaining potato peel residue after extracting the antioxidant. Some of the possible business ideas are the production of the biogas and compost from the leftover, which will be the cheap and easiest idea. Other potential alternatives for the leftover are the production of the household material by mixing it with wood dust, such as spoon, hot pot coaster, or chopping board. Similarly, the production of the ball fire starter by drying it up and mixing it will wooden dust can also be analyzed as a future opportunity from the waste.

- After the company expands its idea, product, and market, licensing the patent to another company in a target country is recommended strategy to enter a foreign market. This strategy quickly expands without much risk and large investment. Additionally, it generated royalty income from existing idea or technology.

References:

- . "Manufacturer producer - antioxidants." from <https://www.europages.co.uk/companies/Manufacturer%20producer/antioxidants.html>.
- . "Natural Antioxidant Buyer ", from <https://www.go4worldbusiness.com/find?searchText=antioxidants&BuyersOrSuppliers=buyers>.
- (2021). Food Packaging Market Fortune Business Insights.
- (2021). Lubricants Market Size, Share, Industry Report Grand View Research.
- (2021). Pharmaceutical Manufacturing Market Size, Grand View Research.
- A. Larry Branen, P. Michael davidson, Seppo Salminen and J. H. T. III (2001). Food Additives.
- Ahsan Javed, Awais Ahmad, Ali Tahir, Umair Shabbir, Muhammas Nouman and A. Hameed (2019). "Potato peel waste- its nutraceutical, industrial and biotechnological applications " AIMS Agriculture and Food **4**(3).
- Akbergenova, Y., K. L. Cunningham, Y. V. Zhang, S. Weiss and J. T. Littleton (2018). "Characterization of developmental and molecular factors underlying release heterogeneity at Drosophila synapses." Elife **7**.
- Asthana, S., R. Jones and R. Sheaff (2019). "Why does the NHS struggle to adopt eHealth innovations? A review of macro, meso and micro factors." BMC Health Serv Res **19**(1): 984-984.
- Athanasopoulou, A. and M. De Reuver (2020). "How do business model tools facilitate business model exploration? Evidence from action research." Electronic Markets **30**(3): 495-508.
- Augustyniak, A., G. Bartosz, A. Cipak, G. Duburs, L. Horakova, W. Luczaj, M. Majekova, A. D. Odysseos, L. Rackova, E. Skrzydlewska, M. Stefek, M. Strosova, G. Tirzitis, P. R. Venskutonis, J. Viskupicova, P. S. Vranka and N. Zarkovic (2010). "Natural and synthetic antioxidants: an updated overview." Free Radic Res **44**(10): 1216-1262.
- BASF. (2022). "Antioxidants." from https://plastics-rubber.basf.com/global/en/plastic_additives/products/antioxidants.html.
- Brown, C. R. (2005). "<Brown2005_Article_AntioxidantsInPotato.pdf>." American Journal of Potato research **82**: 163-172.

- Carocho, M., P. Morales and I. C. F. R. Ferreira (2018). "Antioxidants: Reviewing the chemistry, food applications, legislation and role as preservatives." Trends in Food Science & Technology **71**: 107-120.
- Christensen, C. M. (2001). The Past and Future of Competitive Advantage.
- Ciriminna, R., F. Meneguzzo, R. Delisi and M. Pagliaro (2017). "Olive Biophenols as New Antioxidant Additives in Food and Beverage." ChemistrySelect **2**(4): 1360-1365.
- Company, N. O. P. (1943). Improvements in or relating to antioxidant agents and the stabilization of organic substances against oxidation.
- Costa, R. and L. Santos (2017). "Delivery systems for cosmetics - From manufacturing to the skin of natural antioxidants." Powder Technology **322**: 402-416.
- de Araujo, F. F., D. de Paulo Farias, I. A. Neri-Numa and G. M. Pastore (2021). "Polyphenols and their applications: An approach in food chemistry and innovation potential." Food Chem **338**: 127535.
- de Moraes Crizel, T., A. de Oliveira Rios, V. D. Alves, N. Bandarra, M. Moldão-Martins and S. Hickmann Flôres (2017). "Biodegradable Films Based on Gelatin and Papaya Peel Microparticles with Antioxidant Properties." Food and Bioprocess Technology **11**(3): 536-550.
- de Moraes Crizel, T., A. de Oliveira Rios, V. D. Alves, N. Bandarra, M. Moldão-Martins and S. Hickmann Flôres (2018). "Active food packaging prepared with chitosan and olive pomace." Food Hydrocolloids **74**: 139-150.
- Devi, A., V. K. Das and D. Deka (2018). "Evaluation of the effectiveness of potato peel extract as a natural antioxidant on biodiesel oxidation stability." Industrial Crops and Products **123**: 454-460.
- Dr. Yogesh Hole, S. Pauer and D. M. P. Bhaskar (2019). "Porter's Five Forces Model: Gives You A Competitive Advantages." Journal of Adv Research in Dynamical & Control system **11**.
- El Sheikha, A. F. and R. C. Ray (2017). "Potential impacts of bioprocessing of sweet potato: Review." Crit Rev Food Sci Nutr **57**(3): 455-471.
- Elzbieta Sikora, Ewa Cieslik and K. Topolska (2008). "THE SOURCES OF NATURAL ANTIOXIDANTS." Acta Scientiarum Polonorum Technologia Alimentaria **1**.
- FortuneBusinessInsights (2022). Plastic Additives Market
- G. K. Jayaprakasha, R. P. Singh and K. K. Sakariah (2000). "Antioxidant activity of grape seed (*Vitis vinifera*) extracts on peroxidation models in vitro." Human resource development

Gebrechistos, H. Y. and W. Chen (2018). "Utilization of potato peel as eco-friendly products: A review." Food Sci Nutr **6**(6): 1352-1356.

go4WorldBusiness. "Antioxidants Buyers and Buying Leads ", from <https://www.go4worldbusiness.com/find?searchText=antioxidants&BuyersOrSuppliers=buyers>.

Hindar, K. Disaster in Norway, Norwegian Institute for Nature Research.

Howes, B. D., L. Milazzo, E. Droghetti, M. Nocentini and G. Smulevich (2019). "Addition of sodium ascorbate to extend the shelf-life of tuna meat fish: A risk or a benefit for consumers?" J Inorg Biochem **200**: 110813.

Igor Sepelev and R. Galoburda (2015). "Industrial Potato Peel Waste Application In Food Production " Research for rural development **1**.

Igor Sepelev and R. Galoburda (2015). "Industrial Potato Peel Waste Application In Food Production: A Review." Research for rural development **1**.

Javed, A., A. Ahmad, A. Tahir, U. Shabbir, M. Nouman and A. Hameed (2019). "Potato peel waste-its nutraceutical, industrial and biotechnological applications." AIMS Agriculture and Food **4**(3): 807-823.

Jemima Romola, C. V., M. Meganaharshini, S. P. Rigby, I. Ganesh Moorthy, R. Shyam Kumar and S. Karthikumar (2021). "A comprehensive review of the selection of natural and synthetic antioxidants to enhance the oxidative stability of biodiesel." Renewable and Sustainable Energy Reviews **145**.

Jim Schonrock, Sean Sands, Kit Spielberger, Ally Marshall, Bridget Molitor, Joseph Fawbush, Andrew Leonatti, Laura Temme, Maddy Buck , Jonathan Calvopina, Richard Dahl, Steven J. Ellison, Catherine Hodder, Tim Kelly and S. Bello. (2008). "Food Additives." from <https://corporate.findlaw.com/law-library/food-additives.html>.

Kobayashi, T., M. Nakamura, K. Matsunaga, J. Nakata, K. Tagami, N. Sato, T. Kawabe and Y. Kondo (2021). "Anaphylaxis due to potato starch (possibly caused by percutaneous sensitization)." Asia Pac Allergy **11**(2): e14.

Lopes, J., I. Gonçalves, C. Nunes, B. Teixeira, R. Mendes, P. Ferreira and M. A. Coimbra (2021). "Potato peel phenolics as additives for developing active starch-based films with potential to pack smoked fish fillets." Food Packaging and Shelf Life **28**.

Lourenco, S. C., M. Moldao-Martins and V. D. Alves (2019). "Antioxidants of Natural Plant Origins: From Sources to Food Industry Applications." Molecules **24**(22).

Mahmoud, A. M., F. L. Wilkinson, A. P. Lightfoot, J. M. Dos Santos and M. A. Sandhu (2021). "The Role of Natural and Synthetic Antioxidants in Modulating Oxidative Stress in

Drug-Induced Injury and Metabolic Disorders 2020." Oxidative Medicine and Cellular Longevity **2021**: 1-3.

Majee, S., G. Halder, D. D. Mandal, O. N. Tiwari and T. Mandal (2021). "Transforming wet blue leather and potato peel into an eco-friendly bio-organic NPK fertilizer for intensifying crop productivity and retrieving value-added recyclable chromium salts." J Hazard Mater **411**: 125046.

Marc J. Melitz and G. I. P. Ottaviano (2008). "Market Size, Trade and Productivity." Economic studies **75**: 295-316.

Marc J. Melitz and G. I. P. Ottaviano (2008). "Market Size, Trade, and Productivity." The Review of Economics Studies **75**: 295-316.

MarketDataForecast (2022). Food Additives Market

McFarlane, D. A. (2017). "Osterwalder's business model canvas: Its genesis, features, comparison, benefits and limitations." Westcliff International Journal of Applied Research **1**(2): 24-27.

Mei, J., X. Ma and J. Xie (2019). "Review on Natural Preservatives for Extending Fish Shelf Life." Foods **8**(10).

Michael Antolovich, Paul D. Prenzler, Emiliios Patsalides, Suzanne McDonald and K. Robards (2002). "Methods for testing antioxidant activity." The Royal Society of Chemistry.
Mohdaly, A. A. A., M. A. Sarhan, A. Mahmoud, M. F. Ramadan and I. Smetanska (2010). "Antioxidant efficacy of potato peels and sugar beet pulp extracts in vegetable oils protection." Food Chemistry **123**(4): 1019-1026.

Muthurajan, M., A. Veeramani, T. Rahul, R. K. Gupta, T. Anukiruthika, J. A. Moses and C. Anandharamakrishnan (2021). "Valorization of Food Industry Waste Streams Using 3D Food Printing: A Study on Noodles Prepared from Potato Peel Waste." Food and Bioprocess Technology **14**(10): 1817-1834.

Nogueira, G. F., F. M. Fakhouri and R. A. de Oliveira (2018). "Effect of incorporation of blackberry particles on the physicochemical properties of edible films of arrowroot starch." Drying Technology **37**(4): 448-457.

Phadermrod, B., R. M. Crowder and G. B. Wills (2019). "Importance-Performance Analysis based SWOT analysis." International journal of information management **44**: 194-203.

PRNewswire (2022). Industry Trends, Demand, Value, Analysis & Forecast Report.

Qiao, G. H., X. H. Zhou, Y. Li, H. S. Zhang, J. H. Li, C. M. Wang and Y. Lu (2012). "Effect of several supplemental Chinese herbs additives on rumen fermentation, antioxidant function and nutrient digestibility in sheep." J Anim Physiol Anim Nutr (Berl) **96**(5): 930-938.

- Rahman, M. S. (2007). Handbook of Food Preservation.
- Raju Kale and R. Deshmukh (2022). Antioxidants market by type, form and application : Global opportunity analysis and industry forecast, 2022-2031.
- Ramírez-Jiménez, A., E. Guerra-Hernández and B. García-Villanova (2003). "Evolution of non-enzymatic browning during storage of infant rice cereal." Food Chemistry **83**(2): 219-225.
- Richelle, A., I. Ben Tahar, M. Hassouna and P. Bogaerts (2015). "Macroscopic modelling of bioethanol production from potato peel wastes in batch cultures supplemented with inorganic nitrogen." Bioprocess Biosyst Eng **38**(9): 1819-1833.
- Rulis, A. M. and J. A. Levitt (2009). "FDA'S food ingredient approval process: Safety assurance based on scientific assessment." Regul Toxicol Pharmacol **53**(1): 20-31.
- Santos-Sánchez, N. F., R. Salas-Coronado, R. Valadez-Blanco, B. Hernández-Carlos and P. C. Guadarrama-Mendoza (2017). "Natural antioxidant extracts as food preservatives [pdf]." Acta Scientiarum Polonorum Technologia Alimentaria **16**(4): 361-370.
- Singh, A., K. Sabally, S. Kubow, D. J. Donnelly, Y. Garipey, V. Orsat and G. S. Raghavan (2011). "Microwave-assisted extraction of phenolic antioxidants from potato peels." Molecules **16**(3): 2218-2232.
- Sofia C. Lourenco, Margarida Moldao-Martins and V. D. Alves. (2019). "Antioxidants of Natural Plant Origins: From sources to Food Industry Applications." from <https://www.ncbi.nlm.nih.gov/pmc/articles/PMC6891691/>.
- Soto, M., M. Parada, E. Falqué and H. Domínguez (2018). "Personal-Care Products Formulated with Natural Antioxidant Extracts." Cosmetics **5**(1).
- Stegmann, P., M. Londo and M. Junginger (2020). "The circular bioeconomy: Its elements and role in European bioeconomy clusters." Resources, Conservation & Recycling: X **6**.
- Stockopedia. (2022). from <https://www.stockopedia.com/ratios/sales-cagr-5y-850/>.
- Sun, S. (2009). "An analysis on the Conditions and Methods of Market Segmentation " International Journal of Business and Management **4**(2).
- TheExpressWire (2022). Cosmetics Products Market
- Thomas A. Larsen and F. asche (2011). "Contracts in the Salmon Aquaculture Industry: An Analysis of Norwegian Salmon Exports " Marine Resource Economics **26**.
- Varatharajan, K. and D. S. Pushparani (2018). "Screening of antioxidant additives for biodiesel fuels." Renewable and Sustainable Energy Reviews **82**: 2017-2028.

Venturi, F., S. Bartolini, C. Sanmartin, M. Orlando, I. Taglieri, M. Macaluso, M. Lucchesini, A. Trivellini, A. Zinnai and A. Mensuali (2019). "Potato Peels as a Source of Novel Green Extracts Suitable as Antioxidant Additives for Fresh-Cut Fruits." Applied Sciences **9**(12).

Vera, P., E. Canellas and C. Nerin (2018). "New Antioxidant Multilayer Packaging with Nanoselenium to Enhance the Shelf-Life of Market Food Products." Nanomaterials (Basel) **8**(10).

Weshahy, A. A.-. and V. A. Rao (2012). "

Potato Peel as a Source of Important Phytochemical Antioxidant Nutraceuticals and Their Role in Human Health ".

WRSD (2022). Revenue of the cosmetics market worldwide Statista Research Department Zec, B. Potato Chips in Scandinavia.