Interreg
Alpine Space
EUROPEAN UNION
Alp Bio Eco

AlpBioEco

Results and Replicable Roadmap

Analysis of the bio-based value-chains apples, walnuts and herbs

CONTENT

BIOECONOMY

Bioeconomy means using natural substances for new and alternative products. The most important goals are to replace fossil resources with renewable materials and to find applications for by-products and waste materials. Synergies of technology, ecology and sustainability are harnessed to create new opportunities and prospects for economic activities. By targeting an economic cycle, the concept of bioeconomy comprises raw material sources of agriculture, forestry, water management and waste (food and feed, materials, energy). The transition from a fossil to a bio-based economy reduces society's dependency on fossil fuels and improves sustainability. New business models and cross-industrial innovations are the basis for such transitions. With its raw material sources and diverse economy, the Alpine region has good starting conditions. At this point, the AlpBioEco project comes into place to foster development towards bioeconomy by investigating the valorisation of innovative potentials along bio-based food and botanical extract value chains. In the first work package, AlpBioEco examines the bio-based potential of the three value chains apples, walnuts and herbs.

APPLES

WALNUTS

HERBS

Photo: apple © planet_w lee n kim /// Photo: Walnut picking season walnut tree branches of walnuts opened the shell and the collected walnuts are kept in bulk and broken walnut which is composition on the table Shell nut © allamimages /// Photo: close view on fresh herbs bunch © marcin jucha

ALPBIOECO PROJECT

AlpBioEco was launched in 2018 and investigates with 13 project partners in the Alpine region new bioeconomic potentials. It will contribute to the framework conditions for innovations that will lead to eco-innovative business ideas and concepts for SMEs. The aim is to promote and implement eco-innovation in practice while applying a cross-sector, multi-level stakeholder approach. In the first phase, market and laboratory analyses for the exemplary value chains of apples, walnuts and herbs including Alpine hay are conducted to gain a better understanding and to develop new products. In the next phase, feasible business models for these ideas are created for strengthening local and regional value chains. These concepts will be tested in the third phase before recommendations can be made in phase four. For the geographical delimitation of the study area, the Alpine Space was defined according to the EU Interreg Alpine Space through which AlpBioEco is co-financed (www.alpine-space.eu).

The Alpine Space is characterised by a great diversity of raw materials, local products and industries with great bioeconomic potentials. In order to create future perspectives for the local actors of the Alpine Space and to point out new business opportunities, AlpBioEco focusses on the common value chains of apples, walnuts and herbs including Alpine hay. In the first work package the potentials of the three value chain products were focused by a two-stepped process – market and laboratory analyses. For guiding the research and ensure transferability, criteria were developed based on the project partners experience (see Table 1).

Value chain steps, criteria and FAQs	Information access
general: What seems to be the **bioeconomic potential?**	**>** lab analysis **>** market analysis
raw material: Which **ingredients** are **purchasable or easy to access?** Which ingredients are **already used** for what?	**>** literature review **>** market analysis **>** online research
processing: Which **by-products or leftovers** in the value chain can be identified?	**>** expert interviews **>** lab analysis
processing: What are product and process **innovations?**	**>** literature review **>** online research
economic/comparative advantage: Can local products **substitute imports?**	**>** experts-questionnaires/ literature review
enterprises: What are the **involved companies?**	**>** expert interviews **>** market analysis **>** online research
environmental: Which **type of energy** is consumed in the VC, at what level?	**>** stakeholder involvement
external – public funding and interest, subsidies: Are there ways to **finance innovative approaches** (coming up)? Are there **institutes of the education** sector which can cooperate (with low financial risks)?	**>** expert interviews **>** online research
risks – environmental/economic/social/legal/regulatory: What are strengths or weaknesses? What are **accelerators and brakes?**	**>** SWOT
social: Is there a risk of the VC **causing conflicts/tensions in society?**	**>** expert interviews **>** literature review **>** online research/social media

Table 1: Criteria for the two ways of analysis

SWOT analyses for all value chains were conducted to evaluate internal and external influencing factors. Internal factors are divided into strengths (S) and weaknesses (W) looking at processes, structures and preconditions. External factors are opportunities (O) and threats (T) occurring through the market and the surrounding environment (see chapter 1.3, 2.3, 3.3, 3.4.2). Subsequently, a replicable roadmap as a graphical representation of the methodological approach for application in other bioeconomic value chains was created. The following chapters describe these value chains based on the conducted market and laboratory analyses followed by the SWOTs.

1. APPLES

Apples are mostly associated with table fruits or juice. It appears that the apple market is a saturated one economically. This chapter examines the individual levels of the value chain (production, processing and marketing) such as the associated and researched bioeconomic potentials of apples and its by-products (laboratory research). The chapter outlines the economic and market dimensions as well as the capabilities of the sectors.

1.1. MARKET ANALYSIS

First of all, desk research surveyed secondary statistical sources, which include international databases (e.g., FAOstat, Eurostat) and which were integrated with regional analyses of the respective state institutions from the single countries. Furthermore, available results of publications and statistics on agricultural economics, marketing and fruit cultivation were systematically evaluated in collaboration with the AlpBioEco partners. Secondly, the gathered data were validated and supplemented through quantitative and qualitative expert interviews.

The apple cultivation in the Alps is concentrated on some primary regions. The largest contiguous cultivation territory in terms of area is in the region of Trentino Alto Adige, which is also the most intensively cultivated one (see Figure 1). In contrast to other regions small farms are very important (Garming et al., 2013) and well organised within a cooperative system, while for instance in Baden-Württemberg a trend towards larger farms was noticed. In general, the research has shown that apples are currently mainly processed into products in the food sector for eating apple (Eurostat, 2018), juice, vinegar, puree, pectin, chips. Eating apples obtain prices up to three times higher than other products. Therefore, achieving the highest possible proportion of table apples has a great priority for the producers. The monetary value is reflected in the market potential, which was rated as ‘very good’ especially for organically cultivated table apples by the experts in the online survey. Besides drinks like juice with high market potential, non-food products like animal feed, fertilisers (based on pomace) and apple wood were assessed with low to mean market potentials. All other non-food products were rated as having a low or medium market potential in the online survey.

Regarding the market potential of processed goods, according to the survey a high market potential was estimated for the organic commodities. By-products of the juice production like pomace show high bioeconomic potentials. Other innovative products like apple leather are currently expensive niche products. Through innovative procedures (Gramm et al., 2019), the by-products could be used for medical purposes (pectin, food supplements), cosmetics (apple essence, seed oil), cleaning agents and other products (apple leather, paper). All involved fields such as production, processing and marketing are the basis for the development of novel innovations and further scientific analyses. It appears that apple, regarding this matter, is a mature saturated market.

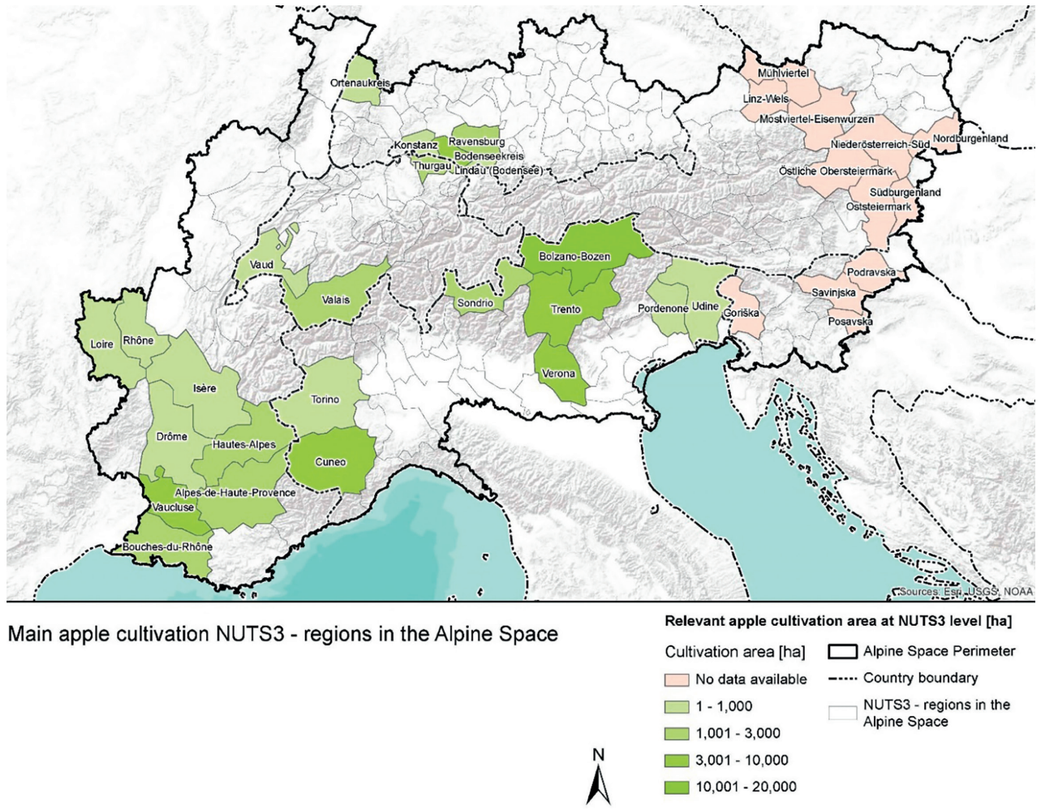


Figure 1: Most important apple-growing regions (NUTS 3) in the Alpine Space. Source: Gramm et al., 2019

The existing bioeconomic potential of apples and its by-products are rarely used in the Alpine Space. Many applications are still under development and lack in economic efficiency. The research indicates that in particular the apple pomace has great potential and could be utilised for various applications, for example with compression moulding for cutlery and straws. Innovative products are currently niche products with high prices in the Alpine Space. New applications were analysed in the laboratory analysis, which is described in the following.

1.2. LABORATORY ANALYSIS

The basic research is an important skill to provide a technical overview of already investigated fields regarding the reuse of apple waste material and by-products. Also, it is a basic structure for discovering potential and novel innovations. That is the reason, why basic research was done by a mind map method. By pre-defined target material and focus areas as cleaning agents and cosmetics, food additives, high tech methods, and renewable products, 13 ideas were selected. Several ideas, which are not yet on the market, were chosen to investigate them on a laboratory scale. The value and necessity of laboratory activities are to verify available functionalities.

All required methods and references can be found on our homepage.

This chapter describes fundamental results regarding raw material characterisation, feasibility analysis for apple wax extraction, phenol extraction as a food additive, yogurt fermentation with apple pomace for a dietary fibre enrichment, smoothies and 3D-printed snacks (figure 2). Additional discovered potential ideas, which have not been analyzed in the laboratory are listed in the following table 2.

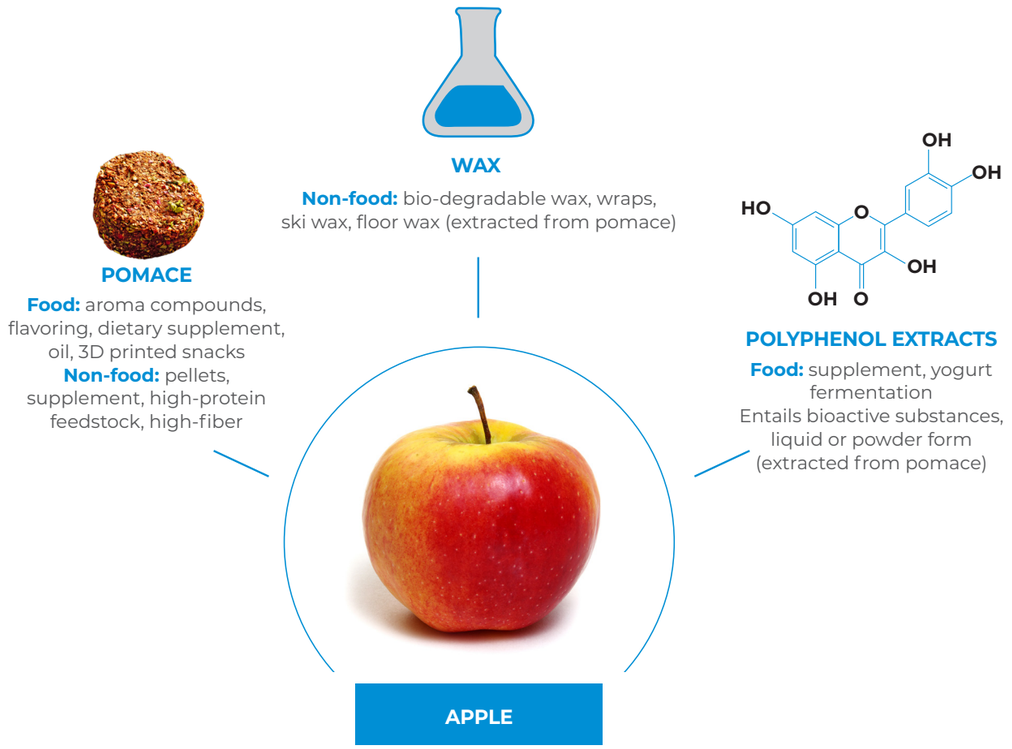


Figure 2: Applications for apple pomace /// Photo: apple pomace © hjochen /// Photo: Fresh red apple isolated on white. © irin-k

The total colony count, particle size and dry matter are determined as a basic raw material characterisation for further product specific experiments. All apple pomace samples of the **microbiological analysis** have been tested on PCA for a total bacterial count with an incubation period of 72 h at 30°C. The highest bacteria concentrations with $6{,}27*10^4$ CFU/g and $1{,}53*10^3$ CFU/g were found in two different apple pomace batches. The lowest concentration was determined in dry apple pomace with $8{,}77*10^2$ CFU/g. The difference in bacteria concentration between humid and dry apple pomace is logically comprehensible. The bacterial growing was minimised due to the drying process. The diversity of bacterial contamination in various humid apple pomaces is explainable with different processing steps, storage conditions and raw material properties.

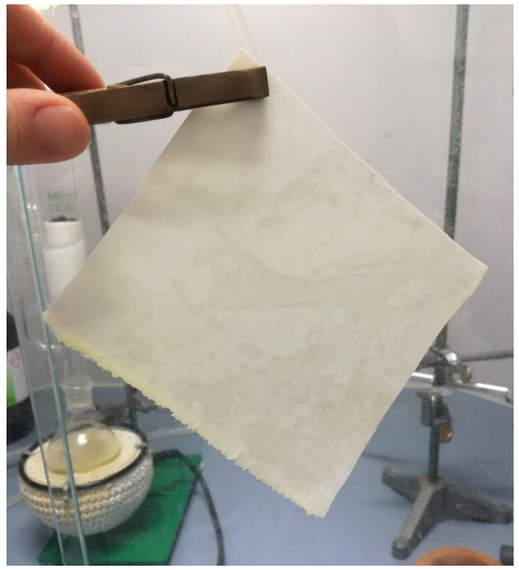


Figure 3: Exemplarily apple wax wrap model
Photo: Apple wax © MCI

For a **wax extraction** from apple pomace the standard Soxhlet extraction method was used. Also, as pre-treatment, acid digestion was done following Matissek et al. 2014 for improving the wax structure and increasing the yield. This study and research of Günther Lang et al. 1996 have obtained comparable results in testing different apple pomace extraction methods in the cosmetic sector. According to our performed experiments, a higher yield is reachable with industrial dried and depectinized pomace. Equally, subsequent treatment of the wax extract with a vacuum evaporator had a positive effect on the yield. Wax wraps are promising and an ideal alternative to plastic wraps to preserve food. Usually, they are made from expensive bee's wax, which can be replaced with extracted wax from apple pomace. Figure 3 shows an exemplarily apple wax wrap model. The layer of the wrap from apple wax was softer and more agile in comparison to bee wax. From this, it can be concluded that apple wax can be additional raw material for making wax wraps and an alternative of plastic.

A **polyphenol extract** from apple pomace can be used as a food additive in various products. The result of first polyphenol extraction experiments shows a low yield of 1,38 g Gallic acid equivalent/kg pomace. The efficiency and realisation of profit have to be assessed individually depending on the effort and feasibility of each eligible company.

The apple pomace in the **yogurt fermentation** has a potential for a dietary fibre enrichment and can influence the texture positively. The result of the germ differentiation by MALDI-TOF shows us the necessity of suitable hygiene measures and after treatments directly by the manufacturer.

Printed smoothie snacks (figure 4) are a possibility to increase the consumption of healthy food. Regarding to first impressions, the printing quality can be improved with the added apple pomace, especially the viscosity and firmness.

Figure 4: Printed cube from apple pomace /// Photo: Printed cube from apple pomace © MCI

Scope	Potential	References
apple wax	+ alternative of ski waxes organofluorine compounds possible changing regulations regarding ski wax compositions + different labelling companies chose to set requirements for other constitute substances + possible maintenance & polishing ability + natural & degradable wax + wax amount of various floor treating & cleaning agents replaced good odour	ski wax: Nordic Ecolabeling 2018 ; Rogowski et al. 2005 Floor treating: Smith and Murphy 1986
wood like pellets	+ alternative energy source + agro pellets for domestic heating boilers + highest combustion efficiency (91,3%) after wood pellets (92,4%)	Verma et al. 2012
leather/ paper	+ natural imitation leather environment risks + bio-degradable + advantages: not inflammable & not toxic energy source	Alberto Volcan 2009
disposable cutlery & straws	+ bio-degradable plastic replacement: sustainable alternative with minimal impact when obtained in sustainable manner + existing cutlery from areca palm & coconut tree + interesting for fast food restaurants, canteens & festivals	Gautam and Caetano 2017; Razza et al. 2009 www.wisefood.de
removal of dyes by biosorption	+ removal potential of different dyes used in various industry sectors (textile, food, plastics, paper) + alternative of expensive active carbon + for the removal of dyes from a synthetic effluent 1 g of pomace (particle size 600 µm)	Robinson et al. 2002
cat litter	+ alternative for bentonite cat litter + existing alternatives: litter from wood (absorbs moisture quickly, binds odours, ecologically, compostable), clay & peanut hulls + high absorption potential of apple pomace	www.jelu-werk.com www.yarrah.com Stephen L. Ivie 1992; Raymond J. Fry 1974
dietary fibre enrichment	+ non-caloric bulking agents for partial replacement of flour (carbohydrates), fat & sugar + apple dietary fibre granules + increased content of phenolic compounds after fermentation of dried pomace in bread production	Galanakis 2018; Struck et al. 2018; Quiles et al. 2018; Rodríguez Madrera et al. 2015

Table 2: Results of additional discovered potential ideas with apple pomace

A meaningful outcome of all performed experiments in the laboratory is the finding that high efficiency can only be reached with the usage of the entire by-product. Preceding processes like extraction can decrease efficiency through further costs and time exposure.

1.3. SWOT APPLES

Internal factors		External factors	
Strengths	**Weaknesses**	**Opportunities**	**Threats**
• huge network of actors • many different sorts • already established quality marks • Italy: one of EU's most important apple producers (33% export share) • production chain simple, well organised • organic cultivation increasingly important • many years of experience in fruit growing • specialised research & educational institutions with focus on apples • different climate zones with good conditions for different varieties • successful regional projects • extensively used orchards promote biodiversity • regional traditions (recipes) • important for characteristic in the regions	• organic apple production is more cost-intensive than conventional • pests • high production costs • unattractive appearance of the growing areas (tourism) • lack of processing, technology structures, lack of innovative strength in marketing structures • classic production competes with bioeconomic use • subsidies are weak • orchards are under pressure (near to outer edge of settlements)	• increase in exports • product quality, variety diversification for market definition • apple industry waste (kernels, shells) to produce sustainable materials • waste from the apple industry for production of phenolic antioxidants • transnational networked research • experience in mountain agriculture (machinery) • production units adapted to climatic zones • large amount of by-products • high bioeconomic potential (tourism, energy sector, quality products with image) • high market potential for processing companies, technology providers • regionality	• competitive pressure due to increased production outside Europe • economic uncertainties in residual inventories • global warming vs. variety suitability • high costs for external equipment • high dependency (diseases, crop failures) • tourism (landscape, conflicts of interest) • shortage of land (housing, prices) • subsidy reduction • water (quality, quantity) • production costs vs. market prices (international comparison) • price fluctuations • lack of acceptance for use of pesticides in society • regional construction boom in rural areas

Table 3: SWOT Apples

1.4. CONCLUSION

The comprehensive analyses of apples indicate useful bioeconomic potentials. The outcome of this research is that the ideal target material for an innovation process is apple pomace because it is available in large quantity as a waste product in the juice industry. The technical screening depends on which kind of reuses and upcycling possibilities already exists with apple pomace and especially where still potentials are. However, all performed experiments in the laboratory show that high efficiency can only be reached with the usage of the entire by-product. Preceding processes like extraction can decrease efficiency through further costs and time exposure. It will be possible to turn the listed weaknesses into opportunities by applying the listed strengths coupled with subsidies and extension of the corresponding opportunities. Research and the corresponding expertise in cultivation, processing and marketing will serve as the basis for exploiting and implementing the opportunities and counter threats along the value-added chain.

Further information can be found in the download section on the AlpBioEco-homepage.

2. WALNUTS

Walnut trees are well known for their largeness, beauty, good workable wood and tasty edible nuts. But there is more to discover: this chapter focuses on cultivation, processing, refining and marketing aspects of walnuts in the Alpine Space as well as potentials of barely used raw materials and by-products coming out of the laboratory analysis.

2.1. MARKET ANALYSIS

In order to get an overview of the market for the value chain of walnuts, several information sources were used. Extensive desktop research was used to gain the available knowledge from databases and publications. Secondly, the relevant information was prepared for an e-mail survey on sub-regional characteristics in the Alpine Space. These tailor-made questionnaires were then presented to experts from all targeted countries, who were identified in close cooperation with the project consortium. The response rate was low but the quality of the expert knowledge and the intensity of the exchange guarantee a solid information base. Figure 5 illustrates the different steps taken in this approach.

Figure 5: Method of market analysis

In food applications, kernels are used (complementary or oil) for fresh consumption, dry fruit/snack (e.g. nut mixes), as valuable ingredients in butter, pesto, cheese, salads, cakes (e.g. Engadiner Nusstorte, Baklava, Grison's cake), bread (Bavarian fruit bread) and meat. Unripe green walnuts are used for local traditional dishes like black nuts, liqueur (Nocino) and pickled green walnuts.

In non-food applications shells can be used as cat litter, building material and thermoplastic, dried leaves for feed, paper and tea, oil for skin care/soap because of its higher contents of polyunsaturated fatty acids which may give walnuts additional anti-atherogenic and cosmetic value (Milind & Deepa 2011). The green shells are utilised for colouring (e.g. hair or textile dye) and as a blasting agent. The walnut wood is used for furniture, jewellery and decoration. Besides these applications walnut products are established as folk medicine in naturopathy and as house remedy (use of walnut oil, kernels, walnut leaves, walnut seeds, etc.). Other usages are grated walnut shell as a cleaning and polishing agent (e.g. for metals, fiberglass), walnut granulate for cleaning intake systems in diesel engines, textile dyes (use of the green peel), animal feed, briquettes/lighters, insulating material or organic pesticide (use of walnut tree leaves). The cultivation areas in the Alpine Space are visualized in Figure 6. The opportunities for bioeconomic exploitation of walnuts and their by-products are shown in table 4.

Figure 6: Cultivation areas of walnuts localized (experts' assessments)

Cultivation areas of walnuts
Localised experts' assessments
Cultivation area
Alpine Space

Concept and cartography: Burkert and Bertram, 2019

Source: AlpBioEco Online survey, Agricorti S.S. 2019, Gîte La Source 2018, LfL (Bayerisches Landesanstalt für Landwirtschaft) 2018, Malavasi 2017, Merle & Richaud 1994, Slow Food 2018, Solar 1990, Solar 2012, Statistik Austria 2018, Stefani & Giovanardi 2014, Trenker et al. 2017, Weidmann 2013

Geodata: © EuroGeographics for the cities and administrative boundaries

Bioeconomic exploitation opportunities	Limits
+ organic pesticides of leaves + shell for biofuel, briquettes, lighters, animal feed or insulating material + hull for textile (Milind & Deepa 2011: 14) + grated walnut shell (walnut flour) as cleaning and polishing agent (Milind & Deepa 2011: 13) + aromatic essentials from green nuts	- know-how and knowledge - marketing strategies to support the sale of bioeconomic products - complete exploitation of the nuts and their by-products by the producers - interest of producers and processors: economically inefficiency (costs for machines) - information by the growers of walnuts about the quantities of by-products possible for processing companies
Innovation potentials	**Obstacles to innovation**
+ process innovation: expansion of regional processing capacities and service offers for walnut producers (cracking machines, oil mills) + innovation/regionalisation in the value chain: sale of walnut kernels to regional customers (health food shops, processors of refined walnut products) + product innovation: bioeconomic exploitation/ complete processing of kernel, membrane, shells	- limited processing capacities (cracking machines, harvesters) and structures (great distance to the nearest processing service) - partially insufficient quality of the walnuts (too small, moist) - small harvests due to small-scale cultivation cannot meet the demand for raw materials - decentralised cultivation structures limit the processing quantities of the walnut (100 % processing is currently unrealistic) - high competition with cheap imports

Table 4: Bioeconomic exploitation opportunities of walnuts and their waste residues (experts' assessments)

Figure 7: Known applications of walnuts /// Photo: Branch of walnut isolated on white background © Anton-Burakov /// Photo: Green walnuts with leaves isolated on a white background © Valentyn Volkov /// Photo: Green walnuts on a white background © TADDEUS /// Photo: Empty walnut shell isolated on white background © NattikaPhoto: Kernel walnut isolated on the white background closeup © Urfin /// Photo: Dry branches isolated on white background © Chengyu /// Photo: Old walnut tree on a white background © Zerbor

The walnut tree is a very valuable plant which offers a great variety of raw material for manifold utilizations (seen in figure 7). The market segments nutrition, wood processing, cosmetics, medicines and also other usages of walnuts and their by-products (e.g. tree leaves, green peel, walnut shell) present the processing possibilities for walnuts. In summary, the market of walnuts in the Alpine Space can be described as a small-scale market with mainly small producers and a few major processing companies. The market is characterised by an investment backlog, especially regarding investments in processing infrastructure. Positive general market developments can be recognised during the last five years (rising sales prices, supportive consumer trends, regionalisation in the value chain). However, these positive market developments have not yet fully reached the local level. Moreover, regional walnut farmers within the Alpine Space are in serious competition with large and cheaper imports of international walnut producers (from China, Iran, Latin America, USA). Securing or reaching a competitive position means in particular to ensure quality.

Amongst the multiple experts' proposals, many ideas and recommendations for action seem promising. The following four types of activities are potentially efficient:

+ establishment of joint quality assurance guidelines by producers and processors
+ supported knowledge exchange between producers and processors (quantities, processing possibilities of certain species, bioeconomic potentials)
+ exploring alternative processing possibilities
+ no one-size-fits-all solution, but activities should be established concerning the local cultivation and processing situation (establishment of cooperatives, funding of regional mills, cracking machines)

2.2. LABORATORY ANALYSIS

The literature shows knowledge gaps concerning ingredients of walnuts (Parle/Khanna, 2011; Schlegel, 2016; Böllersen, 2017). For this reason, sensory and chemical analyses for some components were conducted. Various application tests followed this review.

Firstly, a sensory evaluation with a trained panel of regional walnut kernels was conducted. The individual batches indicated no significant differences: probably kernels from one tree have more varieties than the ones from other trees. These results suggest that there is no consistent raw material which can affect the end-products.

Secondly, the chemical analyses underline the potential of kernels as valuable food due to the high oil and protein rates. Thus, kernels with and without shells are used for oil production. For remaining oil press cakes, which can be used as animal feed as well as for human nutrition, applies the same protein composition (Bakkalbasi et al. 2015). The following figure 8 shows four different randomly selected press cake flours and one as a bar. All press cakes show differences in colour from light to dark brown and in their texture which supports the assumption of inconsistent materials. For high-quality levels, the material should be tested beforehand or purchased from the same tree and mill.

Thirdly, for finding bioeconomic potentials, known applications with walnuts for food, cosmetics and others were searched. Based on this, new ideas were generated by using creative methods like mind-mapping. The concepts for innovative food recipes were developed in a kitchen lab with samples and tested in terms of taste and sensory.

Figure 9:
Walnut Pasta /// Photo: AlpBioEco
Walnut Pasta © AlpBioEco

Fig 8: Press cakes /// Photo: AlpBioEco Press cakes © AlpBioEco

The analyses showed that walnut trees and their components have high potentials. The walnut and its oil contain healthy simple and unsaturated fatty acids as well as a variety of minerals including calcium, iron, magnesium, phosphorus, potassium, sodium, zinc, thiamine, riboflavin, niacin, folate, and vitamin A, B-6, B-12, C, D, E, K (USDA 2018).

For transferring the knowledge from the sensory and chemical analyses, several tests ran in the kitchen lab with the following products:

+ Syrup from green walnuts & aroma extracts from leaves
+ Snack & energy balls with kernels, press cake
+ Pasta (fig. 9), noodles, dough & dumpling with press cake, oil, kernels or leaves
+ Spread sweet or salty with kernels, press cake, leaves or oil including slime
+ Milk & yoghurt from press cake
+ Dessert and ice cream with kernels, press cake
+ Extruding of press cake: tests are running
+ Extrusion-based 3D food printing (Procusini Pro+ of Print2Taste): sweet and savoury mass

Besides uses in the food industry, new ideas for the utilisation of walnut components in cosmetics were developed such as peeling cream with grinded walnut shells, after shave balm with oil & extract and shower oil including feasible conservation tests. Other applications are the use of leaves in tea or tincture and paper production. Paper characteristics regarding brittleness, color and grain depend mainly on composition and leave proportion (figure 10). Furthermore, the investigation of hard and green shells showed colouring properties that can be used for cosmetic and for textiles. First tests for colouring natural fibres (cotton, regional fabrics from nettle, hemp fibres) demonstrate a great colour spectrum depending on the pre-treatments.

The first results showed a wide range of possibilities and ideas with all parts of the walnuts. Its benefits can be used in the food, cosmetics, textile and paper industry and various other areas. Many applications of walnut kernels (oil, press cake), green nuts and walnut leaves were tested in our pilot plants in the kitchen lab. All products showed the typical taste of walnuts. Therefore, it is advisable to combine the walnut press cake with other starchy products to minimise the taste (mostly bitter, astringent, tart, nutty) and to use the sticky properties of conventional flour. After revising food recipes, they can be scaled up for industrial processing.

The processing of walnuts comes with several difficulties. The tasting and sensory evaluations for food products indicated the need for further tests for improving the marketability, durability, storage capability, scalability and processability. It should be noted that walnut oil-containing products can quickly become rancid. The products may contain a high number of harmful aflatoxins after improper storage. That means that careful treatment and refrigerated storage must be guaranteed for direct human consumption. Additionally, it is necessary to sort out and dispose mouldy and rotten nuts before processing. In order to make sure that no toxins are present in the end product, samples should be analysed by laboratory tests.

The use of walnuts in cosmetics produced some promising results. However, the developed recipes should be fundamentally revised, consumer test conducted and legal requirements considered to make it marketable. So far, it has not been possible to produce products with all desired properties and which can maintain its state of aggregation over a long time. Furthermore, the amount and the properties of the end products may vary significantly depending on the nature and quality of the used walnut part. For this reason, it is difficult to make general statements about their applicability and basic recipes.

Currently, product designs are being optimised and other applications of walnut components are being investigated. In addition to the processing in the food industry, the use for papermaking and dyeing of textiles is of particular interest here, as leftovers from food production (leaves or shells) could be utilised here.

Figure 10: Walnut paper /// Photo: Walnut paper © AlpBioEco

2.3. SWOT WALNUTS

Internal factors		External factors	
Strengths	**Weaknesses**	**Opportunities**	**Threats**
• easy to cultivate (alternative for extensive orchards), no danger of voles, deep-rooted, tolerates heavy soils, occasionally soil-wetness • falling fruits get not damaged • broad diversity of varieties • well known, popular cultural assets, proudness on own trees • interesting/valuable substances • demand for wood from walnut trees • some knowhow exists with “IG Nuss” • contribution to biodiversity (insects, feed for wintertime, early bloomer) • subsidies for organic cultivated permanent-crop • multiple uses possible (agro-forest-systems, pasture) • widely consumed due to positive health effects (rich in polyunsaturated fatty acids-omega3 and omega6) • walnut market constantly growing, since walnuts have beneficial properties on health (+53,3 % from 2000 to 2010) • walnut leaves: adstringent, hyperemic, antioxidant, antibacterial • deep root tree, consists deep ground & occasional stagnant moisture • traditional specialities (recipes) • environmentally-friendly form of cultivation, well-established and widely accepted	• structure of cultivation (dispersed trees) • lack of logistics • harvesting costs, processing, technologies (decentralised, manual work) • danger of late frost • different pests (fungus, fruit fly) • suitability for storage if incorrectly handled, sensitivity for mold • no advertising for medicine products possible (”popular” medicine) • less supply with seedlings of different varieties • no research on varieties for more than a century, altogether a lack of research (for example biodiversity) • erosion of knowledge (most specialists already are pensioned) • less knowledge about numbers of trees / plantations wild growing trees, varieties, characteristics • information about healthy ingredients must be better distributed • lack of cooperation between professional institutions and producers (growers)	• great demand, good price • winner of the climate change (tolerates dryness) • undetected varieties/seedlings with new characteristics/potential • diversity of products: leaves (insecticides, plant protection), green nuts • less technical solutions, potential for innovation • substitution of imports possible, demand exists • positive image (regional, untreated) • organic products, a possibility for collective certification (association) • some actors gain interest, start-ups • confederates (SlowFood, www.mundraub.org) • demand from (organic) bakeries • cooperation with handicapped people • buildup of regional know-how, competencies • social elements (meeting point, neighbourhood activities) • new applications in cosmetics, other areas: antibacterizid • restoring orchards: renovation with modern varieties (contemporary assortment) • woodworking/ carpentry: very hard, used for premium & highly valued furniture, one most expensive wood	• maybe looser of climate change (early shoot vulnerability towards late frost) • price competition with other countries (with work costs, degree of mechanization) • new providers on global market (China, Kyrgyzstan), also with their research • ‚niche issue‘ – not much promotion & subsidies • walnuts and oil get rancid • no consistent product quality • seedlings: difficult to achieve sufficient quantity (also quality) of new • allelopathy: walnut tree produces juglone biochemical that decreases growth of other organisms

Table 5: SWOT Walnuts

2.4. CONCLUSION

The analyses show excellent potential for walnuts within the bioeconomic framework in the laboratory and the markets. However, the lack of know-how, logistics, unknown types of walnuts and the vulnerability of the nut are significant obstacles for creating an effective strategy for taking advantage of the promising opportunities related with this tree. A proper strategy, long-term relations between farmers and producers through associations and developing well-defined value chains could overcome these problems.

Further information can be found in the download section on the AlpBioEco-homepage.

3. HERBS

Herbs is a wide ranged field with various applications. The research targets at finding the bioeconomic needle in the haystack. This chapter focuses on cultivation, processing, refining and marketing aspects of herbs, with a closer look on Alpine hay (German ‘Magerheu’) in the Alpine Space. Raw materials and by-products were examined at the laboratory to discover new or unused potentials.

3.1. MARKET ANALYSIS HERBS IN GENERAL

In order to get an overview of the market for the value chain of herbs, several information sources were used in line with the walnut value chain approach (see chapter 2.1). The analysis was conducted stepwise starting with a broad desktop research, followed by expert consultations and evaluation to narrow down possible investigation directions in the laboratory analysis because the superordinated market of herbs is not clearly demarcated.

Due to its great variety and small-scale cultivation, the cultivation of herbs is poorly captured. Figure 11 shows the cultivation area of herbs in respected countries. The European demand for spices and herbs steadily grows due to trends like healthy living, medical uses and sustainability. European buyers continuously look for new local suppliers to meet the high demand and improve traceability.

New trends and opportunities for developing new business models are related to the possibilities to:
+ supply special varieties
+ focus on product characteristics (better colour & taste)
+ customise according to buyer’s preferences
+ produce sustainably (organic, fair trade)

For healthy living, unhealthy food ingredients such as salt, sugar and synthetic additives, are increasingly being replaced by natural ingredients like herbs. Another important health trend in Europe is the intake of various protein products as an alternative to meat consumption and, in this sense, spices and herbs play an important role in the food industry for the possibility to season and imitate the taste of meat. The interest in the use of herbal substances and preparations for medicinal purposes is growing continuously worldwide. The interest in herbal products is mainly based on the assumption of better tolerability compared to synthetic drugs and sufficient efficacy. This is due to the long tradition of natural medicine and the frequent belief that herbal and medicinal products are natural and safe if compared to synthetic pharmaceuticals.

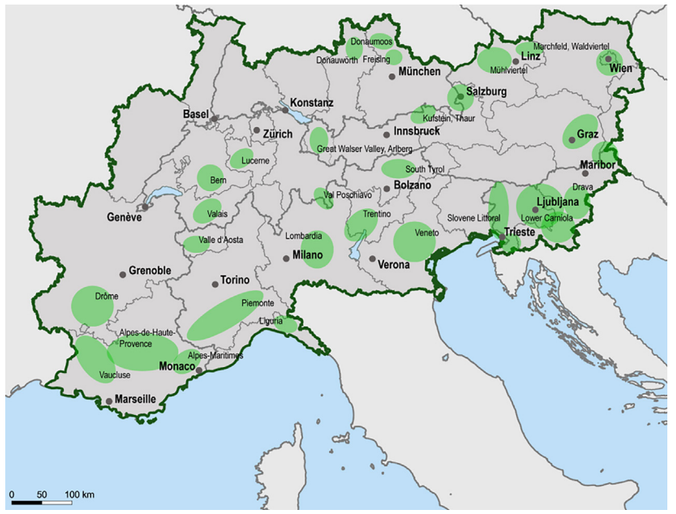


Figure 11: Cultivation areas of herbs – localised experts‘ assessments

The demand for certified cosmetic ingredients is growing. The popularity of organic (mostly with the COSMOS standard) and fairtrade certifications are also driven by the use of these certifications in food products. Germany, France and the United Kingdom also have the highest number of natural product launches and a strong focus on innovation. Cosmetic companies put substantial effort into research for new natural ingredient coming from plants that will replace some synthetic molecules.

It can be seen that bioeconomic possibilities for herbs and their residues are, in particular, the utilisation of plant components for biogas plants, as fertiliser, the production of paper or textile material from plant fibres. The respondents to the market study showed that they are not highly activated by producers or processors. Only the possibility of using raw materials for biogas plants is used more frequently. The experts stated that they have currently no interest in recycling waste residues because it is not economically feasible yet (due to transport costs, personnel costs). Furthermore, there are currently no structures for the purchase of waste residues, possibly because small amounts are used for composting. The results of the market study also indicate that herb producers know little about the bioeconomic potential.

The market for herbs in the Alpine Space is a niche market with mainly small-scale cultivation areas and small producers mainly using their equipment. The market for aromatic and medicinal herbs (especially for dried herbs) is characterised by strong competitive pressure and a high price pressure because of the buyers' power. Also, the cultivation of herbs is cost-intense due to the need for specific technology. Despite these challenging market conditions, the identified potentials along the value chain are rarely exploited within the growing regions (e.g. quality orientation, product diversification, collecting of wild herbs, cultivation of Alpine-specific herbs). The exploitation of the potentials differs in the countries of the Alpine Space. In South Tyrol, for example, can be found other applications than in Slovenia. The survey experts mentioned various (innovation) approaches that could be used to activate unused value creation potentials.

Taken the whole Alpine Space into account, the following four types of activities can be seen as particularly supportive:

+ establishment of joint quality guidelines by producers & processors that ensure a high-quality-standard of Alpine herbs
+ supporting cooperation with regional organisations, umbrella brands & other relevant market players to improve a supra-regional marketing
+ supporting communication between the market players to identify region-specific innovation potentials & possibilities for their joint implementation
+ involvement of machine manufacturers (harvesters, seeders, processing machines) to get information about new technological standards & their implementation possibilities

There is a variety of species of herbs and different cultivation processes in the Alpine Space, for this reason, a multi-approach methodology has been used to set the criteria for the definition of herbs and the evaluation of the relative typologies of laboratory analysis. A preliminary questionnaire has been prepared and fulfilled with information on typologies of herbs, distribution, types of cultivation, use and companies by all PPs in order to give a regional overview of the herbs value chain.
The results obtained from the market analysis revealed the actual uses of herbs, the actors and the value chain organisation together with the most common industrial processes and related by-products or wastes. Moreover, an in-depth scientific literature analysis was done for the evaluation of their potential for the future bio-based application. Throughout these analyses, possible new scenarios in the value chain of herbs have been hypothesised with new products and processes. These possibilities are described in the following table 6.

New products based on herbal by-products	New processes
+ paper + new textile products from nettle or broom + cosmetic products with antioxidants + nutraceutical products with active ingredients + novel ingredient from fungicide or herbicide + new edible plants direct human consumption	+ floral waters for seed tanning in organic agriculture, farms + essential oils as herbicide-antimicrobial-fungicide + essential oil as food preservatives + composting of solid residues from by-products

Table 6: New possibilities for Alpine herbs

3.2. LABORATORY ANALYSIS

One of the common industrial processes in the researched area is the distillation of herbs for essential oils as described in Figure 12.

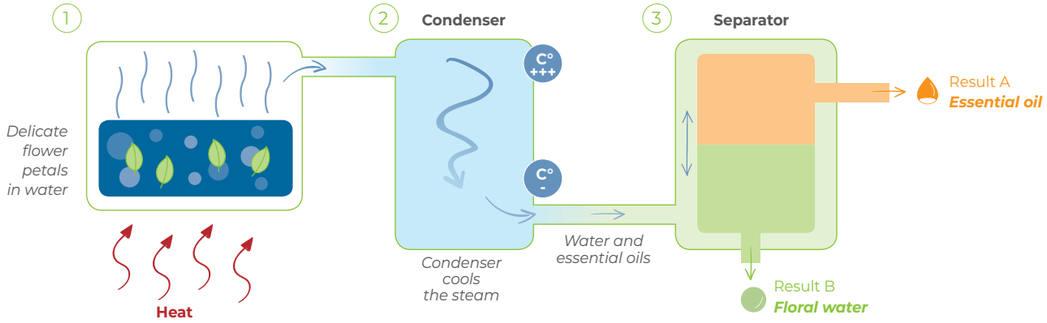


Figure 12: Distillation process

Moreover, essential oils only recently began to be investigated regarding their biological activities and possible alternative uses. Essential oils could be considered as antimicrobial agents enabling a decrease or elimination of preservatives in the cosmetic formulation (Lesage-Meessen, 2015). Moreover, several studies have pointed out the possibility to use essential oils and their components in medical and plant pathology as well as in the food industry for the control of micro-organisms pathogenic to consumers and responsible for food spoilage (Cantore, 2009). With the process for essential oils, floral waters (called hydrolates) and solid wastes occur as by-products. A bibliographic study was done by taking into consideration scientific articles on hydrolates and essential oils from different types of Alpine plants.

This analysis highlights that hydrolates seem to be promising for innovative uses since they still have active molecules:

+ water extract of Rosemary – *Rosmarinus Officinalis* (Wollinger, 2016) entails rosmarinic acid that has strong antibacterial activities, usable both in food industries as well as excipient ingredient in cosmetic & nutraceutical industries
+ water extract of *Lavander – Lavandula Angustifolia* (Śmigielski, 2015) entails linalool & linalyl acetate that have good antibacterial & antifungal activities
+ *Mentha Piperita* extracts (Meng, 2008), show concentration of antioxidants & functional active compounds that prevent the propagation of the lipid peroxidation process in a complex lipid matrix, such as a foodstuff, preservative; it is feasible for seeds tanning in organic agriculture due to their antibacterial activities as substitute of copper

On this basis, a French farm distillery could be identified which produces 27 floral waters, coming from the essential oil distillation process. Samples were analysed for the evaluation of the total antioxidant activities (by DPPH assay) and the phytochemical profile for the determination of the main families of compounds. For all the samples, antioxidant activity was not revealed with DPPH assay on the sample as it is (in contrast with scientific literature), but three different categories of compounds (sugars, peptides and non-polar compounds) were found for all the samples. Only in the case of Artemisia vulgaris hydrosols a different methodology was used to concentrate the constituting molecules for the phytochemistry of the extract for the subsequent HPLC analysis. In this case, the concentrated hydrosol revealed the content of polyphenols and flavonoids.

A different methodology was used for evaluating the presence of active molecules in Lavender water flowers without the concentration step. The gas-chromatography-mass spectrometry (GC-MS) is an analytical method that combines the features of gas-chromatography and mass spectrometry to identify different substances. This analysis reveals that still linalool together with 1,8-Cineole (eucalyptol) and borneol are present in the hydrolysate. These compounds are very interesting for their use as a scent in perfumed hygiene products and their strong activities as an insect repellent (see figure 13).

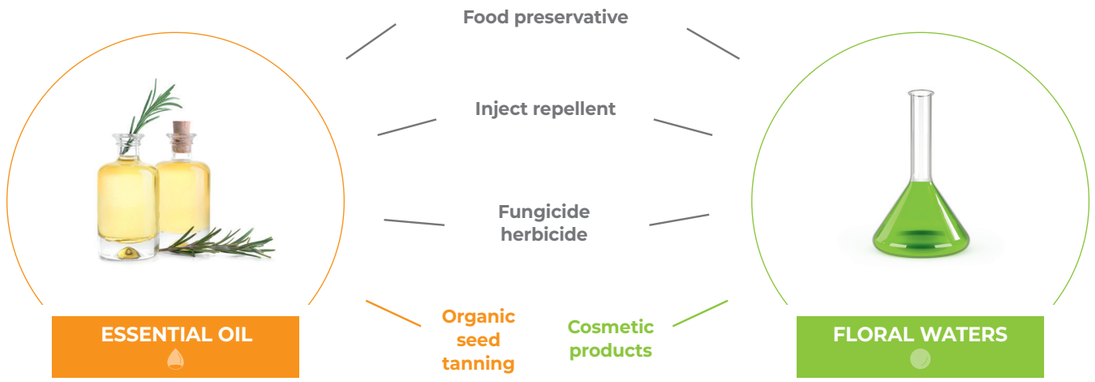


Figure 13: By-products from distillation /// Photo: Bottles with rosemary oil on white background © Pixel-Shot /// Photo: flask with green liquid isolated – illustration © Wth

For completing this study, a review on the typologies of active molecules in hydrolates and the essential oils was done. For every single plant, the most relevant articles were evaluated by taking into consideration the pedo-climatic zone of the plants for giving pertinent information for the Alpine Space territories. A comprehensive overview of the main active molecules found in the essential oils and the hydrolates as well as the specific activity together with the references can be found in the following table 7.

Plants	Essentail Oil/*Hydrosol* Compounds	Specific Activities	References
Achillea millefolium/ **Yarrow**	1,8-cineole, Alpha-thujone, Azulene	Antioxidant activity	Eghdami et al. (2010)
Artemisia vulgaris/ **Mugwort**	1,8-cineole, sabinene, alpha-thujone, alpha-caryophyllene	Antioxidant activity	Blagojevic et al. (2006); Temraz et al. (2008)
Centaurea cyanus/ **Cornflower**	*Hydrosol:* Chlorogenic, caffeic, ferulic, p-coumaric acids, isoquercitrin, coumarin	Anti-hemolytic, anti-hypertensive activity in vitro; antioxidant activity	Bragueto Escher et al. (2018)
Juniperus oxycedrus/ **Cade**	a-pinene, myrcene, limonene, germacrene D, gamma-muurolene	Antifungal and antioxidant activity	Salido et al. (2002); Cavaleiro et al. (2005); Chaouche et al. (2015)
Daucus carota ssp. Maximus/ **Daucus carota**	geranyl acetate, Alpha- pinene/ *Hydrosol*: Root hydrosol: myristicine, (E)-methyl-iso-eugenol, methyl-eugenol. Aerial parts hydrosol: caryophyllene oxide, p-cymene-8-ol	Antifungal activity	Zatla et al. (2017)
Cedrus atlantica/ **Cedar branch**	alpha-pinene, Himachalene, Cadinene	Bactericidal activity	Derwich et al. (2010)
Cupressus sempervirens/ **Cupressus branch**	Alpha-pinene, Cedrol	Moderate antibacterial, antifungal activities	Mazari et al. (2010)
Juniperus communis/ **Juniperus branch and berry**	Alpha-pinene, myrcene, sabinene, limonene, Beta-pinene	Antioxidant activity	Höferl et al. (2014)
Helichrysum italicum/ **Helichrysum**	Alpha-pinene, a-cedrene, aromadendrene, Beta-caryophyllene, limonene, neryl acetate, 2-methylcyclohexyl pentanoate & octanoate, geranyl acetate	Antimicrobial activities, in paticular against Staphylococcus aureus & Candida albicans	Mastelic et al. (2005)
Hyssopus officinalis/ **Hyssop**	isopinocamphone, (-)-Beta-pinene, (-)-terpinen-4-ol, pinocarvone, carvacrol, p-cymene, myrtenal	Moderate antioxidant & antimicrobial activity, potential chemopreventive & immunostimulant effects	Venditti et al. (2015); Aazza et al. (2012); Kizil et al. (2010)
Lavandula angustifolia & cl./ **Fine & Maillette Lavender**	linalool, linalyl acetate, borneol/ *Hydrosol:* linalool, borneol	Antimicrobial and antioxidant properties.	Śmigielski et al. (2013); Prusinowska et al. (2015)
Lavandula hybrida abrialis & super/ **Lavandin Abrialis & super**	linalyl acetate, linalool/ *Hydrosol:* Linalool	Antimicrobial, antioxidant properties	Baydar et al. (2013)
Origanum majorana/ **Marjoram**	terpinen-4-ol, cis-sabinene hydrate, p-cymene, -terpinene/ *Hydrosol:* Chlorogenic, Rutin, Ferulic acid	Antioxidant, free radical scavenging activities	Méabed et al. (2018); Vera et al. (1999)

Table 7 – Part 1: Main active molecules found in essential oils and hydrolates

Plants	Essentail Oil/*Hydrosol* Compounds	Specific Activities	References
Mentha x piperita/ Peppermint	limonene, Carvone D/ *Hydrosol:* 1,8-cineole, Menthone, Menthol	Antioxidant properties	De Sousa Barros et al. (2015); Amr E. Edris (2009); Dorman et al. (2003)
Hypericum perfora-tum/ Hypericum	nonane, p-cymene, 3-methylnonane	Antibacterial activity	Saddiqe et al. (2010); Rančić et al. (2005)
Perilla frutescens/ Perilla Shiso	2-furyl methyl ketone, decahydro1-methyl-2-methylene-naphthalene, limonene, caryophyllene	Insecticidal toxicity and antioxidant activity	Chun Xue You et al. (2014); Meng et al. (2009)
Rosmarinus officinalis/ Rosemary	alpha-pinene, 1,8-cineole, Linalool	Radical-scavenging, antioxidant properties	Gachkar et al. (2006); Deok Hyeon Jeon et al. (2013); Wollinger et al. (2016)
Santolina chamaecyparissus/ Santoline	artemisia ketone, camphor, beta-phellandrene		Demirci et al. (200)
Satureja montana/ Savory	thymol, geraniol	Antimicrobial activity	Ćavar et al. (2008)
Salvia officinalis/ Sage officinalis	1,8-cineole, Alpha-thujone, Beta-thujone, Camphor, Alpha-Humulene	Bacteriostatic and bactericidal activities	Chalchat et al. (1998); Delamare et al. (2007); Aazza et al. (2011)
Salvia sclarea/ Clary Sage	linalyl acetate, linalool, geranyl acetate, R-terpineol	Antifungal activity	Pitarokili et al. (2002)
Thymus vulgaris linaloliferum/ Thyme	thymol, p-cymene, Carvacrol	Antimicrobial activity	Rota et al. (2008)

Table 7 – Part 2: Main active molecules found in essential oils and hydrolates

3.3. SWOT HERBS

	Internal factors		External factors	
	Strengths	Weaknesses	Opportunities	Threats
perfume plants	• high production: almost 20,000 ha lavender, 2,500 ha clary sage • high export share of essential oils • professionalised production, processing, quality control along value chain • efficient distillation through innovations: reduction of energy losses, better profitability of distillation process • altitudes optimal for cultivation of different herb varieties (Alpine to Mediterranean)	• increased disease in lavender 85 % of the acreage makes up a variety • competition from Bulgaria on cloned lavender: tend to lower prices • helpers needed for manual flower harvesting • small-scale farms • scarce associationism among producers leads to fragmented offers • few species cultivated & insufficient quantity to meet demand • potential water shortages	• increasing demand for essential oils • significant development of new markets • high demand for products • new types of lavender, more resistant to diseases • positive external effects: tourism, lavender honey, organic, herbal cosmetics • linking tourism (sales & awareness raising / herbal education) • alternative source of income for mountain farmers	• production must be adapted to climate change • impact of regulatory requirements (range) • damage caused by drought • overproduction of clary sage: price drops • price fluctuations
aromatic plants	• professional production structures: cooperatives, large companies, plant development (especially fresh, frozen plants) • high production growth • good quality assurance • increasing organic production of aromatic plants • strong tradition of gathering, using medicinal and aromatic herbs (SLO) • see last points of perfume plants	• high production costs & for new producers • necessary imports to meet demand • limited plant protection methods, high demand for alternatives • increasingly strict regulations • see last 5 points of perfume plants	• strong traditional markets • new markets in development (plant extracts, nutritional supplements), identified future uses • consumer expectations: local production, high traceability • linking tourism (sales & awareness raising / herbal education) • alternative source of income for mountain farmers	• international competition • competitive foreign production costs • price fluctuations
medicinal plants	• increasing poppy production • high proportion of land in organic farming • professional production, processing structures along the value chain • strong tradition of gathering and using medicinal and aromatic herbs (SLO) • 41 % of area planted with medicinal plants is organic (IT) • medicinal plants and extracts are widely used in food, -supplements, body care and pharmaceutical products • 41 % of the area planted with medicinal plants is organic (IT) • see last points of perfume plants	• high production costs • imports to meet demand • limited crop protection methods, high need for alternative methods • possibility of using medicinal plant extracts as natural insecticides • renewal of farmers have high-cost investments • see last 4 points of perfume plants	• see aromatic plants • linking tourism (sales, awareness raising/herbal education) • alternative source of income for mountain farmers	• international competition • other production methods: fermenters or biotechnology • increasingly stringent regulations: pesticide residues, pyrrolizidine alkaloids; Nagoya Protocol: restriction of research, regulatory threats related to development of standards: hygiene, health, quality • price fluctuations

Table 8: SWOT Herbs

3.4. ALPINE HAY

Alpine hay as a raw material is cultivated on steep mountain meadows. It can be harvested from dry and sunny as well as from wet habitats like hanging moors and headwater marshes. The cultivation of these areas is important because of its value for the unique landscapes and a high degree of biodiversity with a lot of rare and endangered species. Besides the ecological value of the rough pastures also the woodless mountainsides have an essential meaning for the landscape including its value for tourism and regional identity. However, the labour-intensive cultivation of less productive, steep hillside situations does not suit in today's agricultural structure, therefore, additional value adding is needed.

3.4.1. MARKET ANALYSIS

The market research focussed on the research on products and producers based on a literature review and a comprehensive collection of ideas and existing applications. A summary of the result has been used as input for a workshop with regional practitioners in the Walgau region. The practicability of uses, the degree of innovation and the market relevance were discussed from a regional point of view and is the basis for the SWOT analysis.

Alpine hay contains aromatic herbs and gramineous plants in a varying potpourri depending on geologic, climatologic and cultivation patterns. Therefore, the material has no constant set of characteristics. It is not appropriate to deal with detailed laboratory analyses (although a certification according to its use for biodiversity is possible). Quality checks of hay refer to the share of duts and mold spores or are simple visual, manual/sensory or olfactory tests.

Most products made from hay are based on characteristics such as:

+ characteristic contents for human wellbeing (relaxation, blood circulation)
+ specific smell is originating from different contents (coumarin et al.)
+ specific flavour if hay is used for food or beverages
+ specific feel of surface (used with wellness applications or surfaces)
+ specific quality as animal feed (roughage with a high degree of lignified parts)
+ ability to become pressed & formed
+ quality of an energy source for thermic use

The market analysis shows the various potentials for Alpine hay which are listed in figure 14. Typical uses are feed, wellness and food. For example, hay flowers are often used in traditional folk medicine for compresses and medicinal baths. It is said to help for pain relief, anticonvulsant and to build up resistance. Ingredients can be flavonoid, tanning agent, essential oil, coumarin and furanocoumarin.

Figure 14: Product groups identified generated from Alpine hay /// Photo: Timothy Hay © Von Anna Hoychuk

The market analysis points out a broad range of products made from the raw material Alpine hay and that there are unused potentials. The use of pressed hay for through compression or pulp moulding allows to develop a broad range of products, and only a few of the possible products are on the market. Many of the ideas are not feasible for broad application due to the small volumes and varying composition. All kind of products which benefit from the specific quality of the raw material (renewable, olfactoric and haptic quality) can be developed. Such new uses support the extensive use of the meadows. Long-term relations between farmers and producers are helpful to maintain certain meadows and build up new business structures.

3.4.2. SWOT ALPINE HAY

Internal factors		External factors	
Strengths	**Weaknesses**	**Opportunities**	**Threats**
• traditional use in farm cycles: positive effects on animal health, product quality (hay milk, hay meat) • traditional use for naturopathy: active ingredients (flavonoid, tanning agent, essential oil, coumarin, furanocoumarin) • high societal estimation for cultivation of mountain meadows to maintain landscape quality & biodiversity (including the possibility to certify the hay quality concerning biodiversity) • specific characteristics: flavour, smell, feel	• quality raw material is inconsistent regarding the type of meadow, date of harvesting • not declared as food or drug • production which depend on a homogeneous composition of ingredients or content of active substances is difficult to realise/often not possible • effort for harvesting • decentralised, peripheral production, high expenditure on logistics	• wellness, tourism • meaning for conservation of biodiversity • some products with high added value • networks, institutions (regional, stock exchanges, haybath organisation) • contractual, trust-based relationships • order processing by farmers: extracts for products/ direct marketing • largely untapped potential for compressed/3D-formed hay products • paper & cardboard production • hardly researched: insulation, biosorption, carbonisation, fungus mycelium • energetic use depend on energy prices	• use of hay, not Alpine hay as raw material. • intensive use or wrong time of harvesting can decrease the potential for biodiversity, specific quality of meadows • too intensive or incorrect use affects quality • allergenic potential

Table 9: SWOT Alpine hay

3.5. CONCLUSION

In general, herbs and Alpine hay play an important role in the Alpine Space. The analyses show that there is great potential in using those plants in various ways throughout many sectors. The market for herbs represents a niche in the agricultural sector, with small companies that have strong tradition but lack in innovation and with many inexpressive potentialities. The results reveal that herbs producers may benefit from cooperation structures that support market expansion on a supra-regional level by strengthening communication and knowledge exchange.

There are some applications on herbs residues, in particular the use as biomass in biogas plants and some application in the textile industries. Herbs producers could find an economic advantage to use their by-products in different markets, like cosmetics or nutraceutical sectors, where the price of the raw materials are higher and could lead to a new profitable business. Currently, the herbs residues and by-products do not have significant uses due to the lack of logistic structures and their limited economic feasibility. It is important to show the producers future potentials.

Further information can be found in the download section on the AlpBioEco-homepage.

4. REPLICABLE ROADMAP & BOTTOM LINE

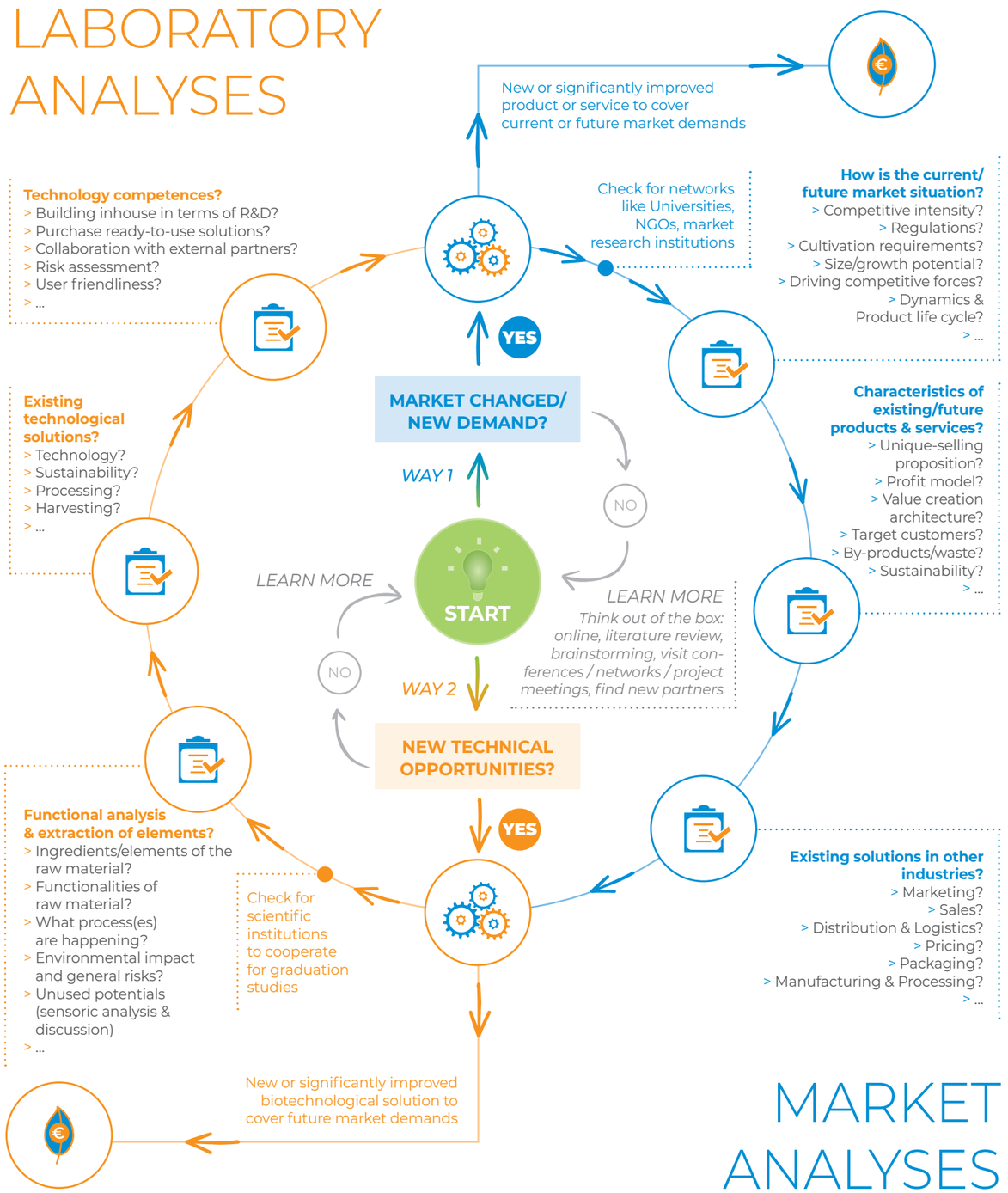
This compact report gives an initial overview over the examined three value chains of apples, walnuts and herbs/hay in the first workpackage of AlpBioEco and builds up the base for further work packages. The comprehensive and detailed analyses and results are available on the AlpBioEco homepage: www.alpine-space.eu/alpbioeco. Comments and knowledge exchange with the project partners are always welcomed. This report represents the deliverable D.T1.2.3 and the Activity A.T1.4.

The research took place over a period of nearly one year and yet, the scope is limited due to time, ressources and data constraints. Nevertheless, the report points out great bioeconomic potentials of the focused value chains in various food and non-food sectors. Especially apple pomace, walnut press cakes and herbal extract by-products are valuable leftovers for new bio-economic applications. Single regions did not show significant differences at the first glance regarding strengths, weaknesses, opportunities and limits whereas all regions have its own relevant characteristics. Some fields could not be focused because of its wide range (e.g. pharmaceutics herbs), seasonal reasons or the limited investigation time – some will be investigated in the ongoing project. There are some lacks of data, e.g. regarding different sorts oft the value chain products and its specific characteristics for which more time and financial capacities are needed. In addition to this practical approaches, basic recommendations become apparant: for regions like the Alpine Space, cooperation for joint innovations and value chains is particularly supportive, as structures are often lacking. Cross-sector cooperations are particularly fruitful for new ideas in other sectors. Actors in the value chains sometimes have to take one step back to make two steps front.

Although the investigated value chains have its specific peculiarities, a replicable roadmap for the analysis of bio-based value chains could be developed (available in different languages on the AlpBioEco-homepage) based on the learnings in the project. The roadmap shall be a standardised guide to analyse value chains with bioeconomic aspects and potentials in regions like the Alpine Space.

What's bioeconomy all about? What are value chain elements? What are waste products and what's inside the waste product? What is unused? Are the identified ingredients usable for my ideas? What could be interesting for b2c or b2b relations? Find new ideas using creative techniques and develop innovative concepts. Try to analyse the relevant chemical properties, discuss and evaluate the results to check feasibility.

REPLICABLE ROADMAP FOR THE ANALYSIS OF BIO-BASED VALUE CHAINS



5. BIBLIOGRAPHY

Aazza et al. (2011): Antioxidant activity of some Morrocan hydrosols Journal of Medicinal Plants Research Vol. 5 (30), pp. 6688-6696.

Aazza et al. (2012): Antioxidant Activity of Eight Hydrosols from Morocco Asian Journal of Plant Sciences 11 (3): 137-142.

Bakkalbasi, E; Meral, R.; Dogan, I. (2015): Bioactive compounds physical and sensory properties of cake made with walnut press cake. Journal of food quality, vol 38.

Baydar et al. (2013): Scent Composition of Essential Oil, Concrete, Absolute and Hydrosol from Lavandin (Lavandula x intermedia Emeric ex Loisel.) Journal of Essential Oil Bearing Plants, 12:2, 131-136.

Benvenutti, Laís; Bortolini, Débora Gonçalves; Nogueira, Alessandro; Zielinski, Acácio Antonio Ferreira; Alberti, Aline (2019): Effect of addition of phenolic compounds recovered from apple pomace on cider quality. In LWT 100, pp. 348–354. DOI: 10.1016/j.lwt.2018.10.087.

Blagojevic et al. (2006): Chemical Composition of the Essential Oils of Serbian Wild-Growing Artemisia absinthium and Artemisia vulgaris J. Agric. Food Chem., 54, 4780−4789.

Böllersen, Vivian (2017): Revival der Walnuss: Neues und altes Wissen zum Walnussanbau in Deutschland, OLV Verlag.

Bragueto Escher et al. (2018): Chemical study, antioxidant, anti-hypertensive, and cytotoxic/cytoprotective activities of Centaurea cyanus L. petals aqueous extract Food and Chemical Toxicology 118, 439–453.

Cantore, Lo; Shanmugaiah, V. and Iacobellis N. S. (2009): Antibacterial Activity of Essential Oil Components and Their Potential Use in Seed disinfection P J. Agric. Food Chem.

Cavaleiro et al. (2005): Antifungal activity of Juniperus essential oils against dermatophyte, Aspergillus and Candida strains. Journal of Applied Microbiology ISSN 1364-5072.

Ćavar et al. (2008): Chemical composition and antioxidant and antimicrobial activity of two Satureja essential oils, Food Chemistry 111, 648–653.

Chalchat et al. (1998): Study of Clones of Salvia officinalis L. Yields and Chemical Composition of Essential Oil. Flavour and Fragance Journal, Vol. 13, 68-70.

Chaouche et al. (2015): Antioxidant, haemolytic activities and HPLC–DAD–ESI–MSn characterization of phenolic compounds from root bark of Juniperus oxycedrus subsp. oxycedrus Industrial Crops and Products 64 (2015) 182–187.

Chun Xue You et al. (2014): Chemical composition and insecticidal activities of the essential oil of Perilla frutescens (L.) Britt. aerial parts against two stored product insects. European Food Research and Technology 239:481–490.

De Sousa Barros et al. (2015): Chemical composition and functional properties of essential oils from Mentha species Industrial Crops and Products 76 (2015) 557–564.

De Souza de Azevedo; Aliakbarian; Casazza; LeBlanc; Perego; De Souza Oliveira (2018): Production of fermented skim milk supplemented with different grape pomace extracts: Effect on viability and acidification performance of probiotic cultures. In PharmaNutrition (6).

Delamare et al. (2007): Antibacterial activity of the essential oils of Salvia officinalis L. and Salvia triloba L. cultivated in South Brazil Food Chemistry 100, 603–608.

Demirci et al. (2000): Chemical Composition of Santolina chamaecyparissus L. Essential Oil J. Essent. Oil Res., 12, 625-627.

Deok Hyeon Jeon et al. (2013): Composition Analysis and Antioxidant Activities of the Essential Oil and the Hydrosol Extracted from Rosmarinus officinalis L. and Lavandula angustifolia Mill. Produced in Jeju. J. Appl. Biol. Chem. 56(3), 141−146.

Derwich et al. (2010): Chemical Composition and In Vitro Antibacterial Activity of the Essential Oil of Cedrus atlantica.

Dorman et al. (2003): Antioxidant Properties and Composition of Aqueous Extracts from Mentha Species, Hybrids, Varieties, and Cultivars. J. Agric. Food Chem., 51, 4563-4569.

Dorman, H.J.; Kosar, M.; Kahlos, K.; Holm, Y. and Hiltunen, R. (2009): Antioxidant Activities of Polyphenols Extracted from Perilla frutescens Varieties Molecules.

Edris, Amr (2009): Identification and Absolute Quantification of the Major Water-Soluble Aroma Components Isolated from the Hydrosols of Some Aromatic Plants Jeobp 12 (2) pp. 155-161.

Eghdami et al. (2010): Determination of Total Phenolic and Flavonoids Contents in Methanolic and Aqueous Extract of Achillea Millefolium Org. Chem. J. 2, 81-84.

Eurostat (2018): Pflanzliche Erzeugnisse in EU-Standard Feuchtigkeitsgehalt. Accessed on: 17.12.18.

FAOSTAT (2018): Producer Prices Annual. Accessed on: 25.01.19.

Gachkar et al. (2006): Chemical and biological characteristics of Cuminum cyminum and Rosmarinus officinalis essential oils, Food Chemistry, Vol.102(3), pp. 898-904.

Galanakis, Charis M. (2018): Food Waste Recovery: Prospects and Opportunities. In: Sustainable Food Systems from Agriculture to Industry: Elsevier, pp. 401–419.

Gautam, Anirudh Muralidharan; Caetano, Nídia (2017): Study, design and analysis of sustainable alternatives to plastic takeaway cutlery and crockery. In Energy Procedia 136, pp. 507–512. DOI: 10.1016/j.egypro.2017.10.273.

Gramm, V.; Dellantonio, S. and Hoffmann, C. (2019): Market Potential Analysis for Regional Products in the Alpine Space, Value Added Chain – Apple. Report Alpine Space Project AlpBioEco.

Höferl et al. (2014): Chemical Composition and Antioxidant Properties of Juniper Berry (Juniperus communis L.) Essential Oil. Action of the Essential Oil on the Antioxidant Protection of Saccharomyces cerevisiae Model Organism.

Holland, Sonia; Foster, Tim; MacNaughtan, William; Tuck, Chris (2018): Design and characterisation of food grade powders and inks for microstructure control using 3D printing. In Journal of Food Engineering 220, pp. 12–19. DOI: 10.1016/j.jfoodeng.2017.06.008.

International Organization for Standardization (2014): ISO 11133:2014 Microbiology of food, animal feed and water - Preparation, production, storage and performance testing of culture media. ISO 11133:2014, p. 99. Available online at https://www.iso.org/standard/53610.html

Jiang, Jishao; Huang, Yimei; Liu, Xueling; Huang, Hua (2014): The effects of apple pomace, bentonite and calcium superphosphate on swine manure aerobic composting. In Waste management (New York, N.Y.) 34 (9), pp. 1595–1602. DOI: 10.1016/j.wasman.2014.05.002.

Josuttis, Patz; Hofmann, Dietrich (2010): Test systems for the measurement of antioxidant ingredients: Application, possibilities and limits - A comparison of methods. In Deutsche Lebensmittel-Rundschau: Zeitschrift für Lebensmittelkunde und Lebensmittelrecht 106.

Journal of Food Quality (2015).

Kizil et al. (2010): Chemical Composition, Antimicrobial and Antioxidant Activities of Hyssop (Hyssopus officinalis L.) Essential Oil Not. Bot. Hort. Agrobot. Cluj 38 (3), 99-103.

Kofler, Ludwig; Kofler, Walter (1949): ber eine Heizbank zur raschen Bestimmung des Schmelzpunktes. In Mikrochim Acta 34 (4), pp. 374–381. DOI: 10.1007/BF01413015.

Lang, G.; Hoch, D.; Konrad, E.; Geibel, W.; Wendel, H.; Kripp, T. (1996): Cosmetic compositon for treating skin and hair containing apple wax and methods of making them on 2/12/1996. App. no. 598.632. Patent no. 5.587.174.

Lesage-Meessen, L.; Bou, M.; Sigoillot, J.-C.; Faulds, C. B.; Lomascol, A. (2015): Essential oils and distilled straws of lavender and lavandin: a review of current use and potential application in white biotechnology. Appl Microbiol Biotechnol.

Lille, Martina; Nurmela, Asta; Nordlund, Emilia; Metsä-Kortelainen, Sini; Sozer, Nesli (2018): Applicability of protein and fiber-rich food materials in extrusion-based 3D printing. In Journal of Food Engineering 220, pp. 20–27 DOI:10.1016/j.jfoodeng.2017.04.034.

Lopes-Lutz, D.; S. Alviano, D.; S. Alviano, C.; P. Kolodziejczyk, P. (2008): Screening of chemical composition, antimicrobial and antioxidant activities of Artemisia essential oils, Phytochemistry, Vol.69(8), pp.1732-1738.

Mao, X.; Hoa, Y. (2012): Composition, Structure and functional properties of protein concentrates and isolates produced from walnut. In. J. Mol. Sci 2012,13(2), 1561-1581.

Mastelic et al. (2005): Composition and antimicrobial activity of Helichrysum italicum essential oil and its terpene and terpenoid fractions Chemistry of Natural Compounds, Vol. 41, No. 1.

Matissek, Reinhard; Steiner, Gabriele; Fischer, Markus (2014): Lebensmittelanalytik. Berlin, Heidelberg: Springer Berlin Heidelberg.

Maxia et al. (2008): Chemical characterization and biological activity of essential oils from Daucus carota L. subsp. carota growing wild on the Mediterranean coast and on the Atlantic coast Fitoterapia, Vol.80(1), pp.57-61.

Mazari et al. (2010): Chemical composition and antimicrobial activity of essential oils isolated from Algerian Juniperus phoenicea L. and Cupressus sempervirens L.

Méabed et al. (2018): Chemical analysis of aqueous extracts of Origanum majorana and Foeniculum vulgare and their efficacy on Blastocystis spp. cystsPhytomedicine 43, 158-163.

Meng et al. (2009): Antioxidant Activities of Polyphenols Extracted from Perilla frutescens Varieties Molecules, 14, 133-140.

Meng, L.; Lozano, Y. F.; Gaydou, E. M.; Li, B. (2003): Antioxidant Properties and Composition of Aqueous Extracts from Mentha Species, Hybrids, Varieties, and Cultivars. J. Agric. Food Chem.

Parle, M.; Khanna, D. (2011): Walnut: Not a hard nut to crack. In: International Research Journal Of Pharmacy 2 (5), pp. 8-17.

Pitarokili et al. (2002): Composition and Antifungal Activity on Soil-Borne Pathogens of the Essential Oil of Salvia sclarea from Greece Agric. Food Chem., 50, 6688-6691.

Prusinowska et al. (2015): Hydrolates from lavender (Lavandula angustifolia) – their chemical composition as well as aromatic, antimicrobial and antioxidant properties Natural Product Research, 30:4, 386-393.

Quiles, Amparo; Llorca, Empar; Schmidt, Carolin; Reißner, Anne-Marie; Struck, Susanne; Rohm, Harald; Hernando, Isabel (2018): Use of berry pomace to replace flour, fat or sugar in cakes. In Int J Food Sci Technol 53 (6), pp. 1579–1587. DOI: 10.1111/ijfs.13765.

Rančić et al. (2005): Chemical Composition and Antimicrobial Activities of Essential Oils of Myrrhis odorata (L.) Scop, Hypericum perforatum L and Helichrysum arenarium (L.) Moench Journal of Essential Oil Research, 17:3, 341-345.

Raymond, J. Fry (1974): cedar-based animal litter on 10/20/1974. App. no. 513,559. Patent no. 3,941,090.

Razza, Francesco; Fieschi, Maurizio; Degli Innocenti, Francesco; Bastioli, Catia (2009): Compostable cutlery and waste management: an LCA approach. In Waste management (New York, N.Y.) 29 (4), pp. 1424–1433. DOI: 10.1016/j.wasman.2008.08.021.

Robinson; Chandran; Nigam (2002): Removal of dyes from a synthetic textile dye effluent by biosorption on apple pomace and wheat straw. In Water Research 36 (11), pp. 2824–2830. DOI: 10.1016/S0043-1354(01)00521-8.

Rodríguez Madrera, Roberto; Pando Bedriñana, Rosa; Suárez Valles, Belén (2015): Production and characterization of aroma compounds from apple pomace by solid-state fermentation with selected yeasts. In LWT - Food Science and Technology 64 (2), pp. 1342–1353. DOI: 10.1016/j.lwt.2015.07.056.

Rodrigues Silva Câmara, C.; Schlegel, V. (2016): A review on the potential human health benefits oft he black walnut. Journal of Food Properties.

Rogowski, Isabelle; Gauvrit, Jean-Yves; Léonard, Didier; Lanteri, Pierre (2005): Typology of the gliding waxes in cross-country skiing: Comparison between classifications based on the chemical composition and those based on the physical and physicochemical properties. In Cold Regions Science and Technology 43 (3), pp. 140–149. DOI: 10.1016/j.coldregions.2005.03.002.

Rota et al. (2008): Antimicrobial activity and chemical composition of Thymus vulgaris, Thymus zygis and Thymus hyemalis essential oils Food Control 19, 681–687.

Saddiqe et al. (2010): A review of the antibacterial activity of Hypericum perforatum L Journal of Ethnopharmacology 131 (2010) 511–521.

Salido et al. (2002): Chemical studies of essential oils of Juniperus oxycedrus ssp. Badia Journal of Ethnopharmacology 81, 129 /134.

Severini, C.; Derossi, A.; Ricci, I.; Caporizzi, R.; Fiore, A. (2018): Printing a blend of fruit and vegetables. New advances on critical variables and shelf life of 3D edible objects. In Journal of Food Engineering 220, pp. 89–100. DOI: 10.1016/j.jfoodeng.2017.08.025.

Singleton; Rossi (1965): Colorimetry of total phenolics with phosphomolybdic-phosphotunstic acid reagent.

Śmigielski et al. (2013): Comparison of qualitative and quantitative chemical composition of hydrolate and essential oils of lavender (Lavandula angustifolia) The Journal of Essential Oil Research, Vol. 25, No. 4, 291–299.

Śmigielski, K. B.; Prusinowska, R.; Krosowiak K. & Sikora M. (2015): Comparison of qualitative and quantitative chemical composition of hydrolate and essential oils of lavender (Lavandula angustifolia) Natural Product Research.

Smith; Murphy (1986): Floor cleaning and waxing composition. App. no. 739,129. Patent no. 4.565.644.

Stephen L. Ivie (1992): Animal litter granules and method of processing peanut hulls in producing cat litter on 9/29/1992. App. no. 954,696. Patent no. 954,696.

Struck, Susanne; Straube, Denise; Zahn, Susann; Rohm, Harald (2018): Interaction of wheat macromolecules and berry pomace in model dough: Rheology and microstructure. In Journal of Food Engineering 223, pp. 109–115. DOI: 10.1016/j.jfoodeng.2017.12.011.

Temraz et al. (2008): Characterization of antioxidant activity of extract from Artemisia vulgaris Pak. J. Pharm. Sci., 21.

USDA (2018): National Nutrient Database, URL: https://ndb.nal.usda.gov/ndb/foods/show/04528?fgcd=&manu=&format=&count=&max=25&offset=&sort=default&order=asc&qlookup=walnut&ds=&qt=&qp=&qa=&qn=&q=&ing= (06.03.2019).

Venditti et al. (2015): Essential oil composition, polar compounds, glandular trichomes and biological activity of Hyssopus officinalis subsp. aristatus (Godr.) Nyman from central Italy Industrial Crops and Products, December 23, Vol.77, pp.353-363.

Vera et al. (1999): Chemical composition of the essential oil of marjoram (Origanum majorana L.) from Reunion Island Food Chemistry 66 (1999) 143-145.

Volcan, Alberto (2009): Composition based on products stemming from industrial residues in the processing od fruits, especially apples use thereof, method for processing them and products thus obtained. App. no. 12/309,681. Patent no. 20090301347.

Wang, Xinya; Kristo, Eleana; LaPointe, Gisèle (2019): The effect of apple pomace on the texture, rheology and microstructure of set type yogurt. In Food Hydrocolloids 91, pp. 83–91. DOI: 10.1016/j.foodhyd.2019.01.004.

Wenning, Mareike; Breitenwieser, Franziska; Konrad, Regina; Huber, Ingrid; Busch, Ulrich; Scherer, Siegfried (2014): Identification and differentiation of food-related bacteria: A comparison of FTIR spectroscopy and MALDI-TOF mass spectrometry. In Journal of microbiological methods 103, pp. 44–52. DOI: 10.1016/j.mimet.2014.05.011.

Wollinger et al. (2016): Antioxidant activity of hydro distillation water residues from Rosmarinus officinalis L. leaves determined by DPPH assays Comptes Rendus Chimie 19, 754-765.

Zatla et al. (2017): Antifungal activities of essential oils and hydrosol extracts of Daucus carota subsp. sativus for the control of fungal pathogens, in particular gray rot of strawberry during storageJournal of Essential Oil Research, VOL. 29, NO . 5, 391–399.

Group photo at the AlpBioEco project partners' meeting in May 2019 in Ljubljana, Slovenia /// Photo: CCIS – CAFE archive © CCIS – CAFE

CONTACT PERSON

Gloria Kraus
Project Coordinator "AlpBioEco"

InnoCamp Sigmaringen
Marie-Curie-Str. 20 · D-72488 Sigmaringen

Tel: +49 75 71 / 9 27 92 72 · Mobile: +49 174 / 3 47 03 38
Email: kraus@sigmaringen.de

This report was produced as part of the AlpBioEco project, which is co-financed by the European Regional Development Fund through the Interreg Alpine Space programme.

IMPRINT

Published by:
AlpBioEco project
InnoCamp Sigmaringen
Marie-Curie-Str. 20 · D-72488 Sigmaringen
www.alpine-space.eu/projects/alpbioeco

Where to order the publication:
Tel: +49 75 71 / 9 27 92 72
Email: kraus@sigmaringen.de

Date: May 2019

Design: Rainer Görsch | Visual Communication

Printed on recycled paper

Interreg
Alpine Space
EUROPEAN UNION

Alp Bio Eco

ABOUT US

You want to know more details about our research?

Please find more detailed documents on our homepage:
www.alpine-space.eu/alpbioeco

Interested in the latest news?
Subscribe to the newsletter on our website.

Follow us on:

AlpBioEco
#AlpBioEco

AlpBioEco

AlpBioEco

Please contact us, we will be happy to advise you!

CONTACT

Gloria Kraus ||| Project coordination ||| EU Interreg Project AlpBioEco ||| kraus@sigmaringen.de

PROJECT PARTNERS

BIOTEHNIŠKI CENTER NAKLO
BUND FRIENDS OF THE EARTH GERMANY
ENVIRONMENT PARK Parco Scientifico Tecnologico per l'Ambiente
Gospodarska zbornica Slovenije Chamber of Commerce and Industry of Slovenia Chamber of Agricultural and Food Enterprises
Hochschule Albstadt-Sigmaringen Albstadt-Sigmaringen University
TECHPARK SÜDTIROL / ALTO ADIGE
ITKAM CAMERA DI COMMERCIO ITALIANA PER LA GERMANIA ITALIENISCHE HANDELSKAMMER FÜR DEUTSCHLAND
IMWALGAU
KErn Kompetenzzentrum für Ernährung
MCI DIE UNTERNEHMERISCHE HOCHSCHULE
SIGMARINGEN
terralia
business upper austria

PROJECT FUNDERS

EUROPEAN UNION

This project is co-financed by the European Regional Development Fund (ERDF) through the Interreg Alpine Space programme.
Support from the European Union: 1.820.666 €

Federal Ministry of the Interior, Building and Community

This project is funded by the "Federal Transnational Cooperation Programme" of the German Federal Ministry of the Interior, Building and Community