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Mountain food as a natural probiotic: Evidence from Central and Eastern European nutrition and behaviour

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Abstract

The present work discussed the importance of mountain foods/products and services in the context of healthier nutrition and behaviour with the application to agribusiness. It highlighted the necessity of human behaviour in consuming mountain products as natural probiotics. It analysed mountain food and the associated entrepreneurship for Austria and other Central and Eastern European countries (foods/products and services), especially from the mountain area. The Eurostat database used experimental and clinical research regarding representative mountain food from Central and Eastern European areas. Data from Eurostat are processed in Excel and SPSS, using similar models of analysis from published papers. Experimental analysis was obtained and collected from different recognised sources. The clinical study is family-based background. Results presented mountain products with natural probiotic effects, and pointed out the importance of useful Central and Eastern European natural probiotics, namely yogurt, *Allium sativum* (garlic), natural honey, and the Austrian entrepreneurship of mountain products model followed by the Central and Eastern European countries. Central and Eastern European countries present important mountain products such as natural probiotics, useful for healthier nutrition and behaviour. Mountain entrepreneurship has developed significantly in the last decade; people from these areas recognise the importance of mountain products in developing healthier nutrition and behaviour.

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Introduction

The present work was under the context of the U.N. 2022, the International Year of Sustainable Mountain Development. The mountain researchers consider mountain foods, based on experimental analysis, to contain superior nutritional values with natural probiotic effects. According to some researchers (Richer, 2020; Bermejo López *et al*., 2021; Fernandes *et al*., 2021; Djordjevic *et al*., 2022; Vishwakarma *et al*., 2022), mountain food contains immune-competence vitamins such as A, B, C, D, and E, and minerals such as iron, selenium, magnesium, and zinc. The enumerated complex has importance in the SARS-CoV-2 context. Different mountain products offer the entire spectrum of vitamins and minerals necessary for organism immunodeficiency. Clinical analysis of the paper specifies *Allium sativum* (garlic), natural honey, and yogurt as mountain products with probiotic effects in the pandemic background.

Countries from Central and Eastern European (CEE), predominantly mountainous, emphasise the importance of mountain foods and services, and invest important amounts in mountain entrepreneurship. The CEE countries' mountain foods and services are more dynamic in the latest years. The Austrian model could be an optimal solution for sustainable and qualitative food and services entrepreneurship for the mountain area. In the CEE countries, mountain foods give natural probiotic effects. The degree of entrepreneurship increased

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considerably especially in the mountain area, without considering the context of healthy eating and services performed under normal conditions.

The present work analysed relevant mountain food/products from CEE countries as natural probiotics with superior nutritional values and associated sectors and indicators, and proposed the Austrian model to be followed by the other countries. The present work showed that healthy nutrition and behaviour could be implemented at a superior level in the mountain area due to the natural complex of the air-water-soil being less polluted than in the low-land areas. Furthermore, the mountain area has lower degree of pollution, thus providing more opportunities for food businesses in this region (Haleh *et al.*, 2018; Mosaffaie and Salehpour Jam, 2021).

The ecosystem and the determinants of an area affect its food system. High altitude areas (mountains) are less polluted than low altitude areas (plain or hilly). These factors allow mountain areas to offer a healthier environment, with healthy fodder and animals, thus contributing to the production of high-quality food. Mountain farming can only be achieved on a small scale, using sustainable local resources and conserving biodiversity (Steinhäuser, 2020).

Agro-food and services behaviour developed by Austrian mountain entrepreneurs, especially from the mountain area followed by CEE countries, must be understood as a social consequence of consuming specific foods and services to guarantee the freedom of respecting the ecosystem (Ogunyona *et al.*, 2017; Zuliani *et al.*, 2018; Ahmed and Nesreen, 2020; Forero-Cantor *et al.*, 2020). In the present work, mountain agribusiness was referred to as mountain entrepreneurship.

Mountain products highlight the nutritional values of the food as a natural probiotic. Mountain foods have antimicrobial properties. According to Jiang *et al*. (2020), natural probiotics are classified into three subgroups based on structural assets, subgroup 1: fasamycins (antimicrobial); subgroup 2: formicamycin (anti-infection); and subgroup 3: naphthacemycin (antibacterial). Natural probiotics are obtained from living organisms such as bacteria and fungi.

Multidisciplinary approaches to nutrition focus on four aspects: the impact of how food is chosen on attitudes, beliefs and knowledge; the cultural and symbolic complexity of food; social processes and food behaviour; and microeconomic influences on food behaviour (Ock *et al*., 2010; Murcott, 2018; Chen and Chen, 2019; Hanušovský *et al*., 2020).

Another important coordination of the freedom of food and services, healthy nutrition and behaviour, are related to the emotional complexity of the individual or group considered. The emotional complex that leads to a certain type of diet or service is a coordinate of psychobiological stress, the emotional state created by a certain context, and the amount of food or service consumed (Garrido-Castro and Torres-Ruiz, 2019; Soltani *et al*., 2020).

Mountain entrepreneurs from CEE countries must understand the social enterprise responsibility and build their model following the Austrian way of food and services.

Materials and methods

The present work considered the mountain products as natural probiotics, and analysed mountain entrepreneurship's food and services to propose solutions for agribusiness sustainability. Different mountain products (*Allium sativum* - garlic, natural honey, and yogurt) were used in a clinical study on a family-based background (two females - 44 and 77 years and two males - 44 and 73 years). Mountain products have been chosen according to Federal Health Care Facility, USA (Richer, 2020). The subjects agreed to consume mountain products for 40 days without any other changes in current nutrition and diet, and immunodeficiency analysis was obtained at the beginning and the end of the period (January - March 2022). The mountain products have been tested before use, presenting superior nutritional values (fluctuation of the values have been taken into consideration only for positive values; negative fluctuation were under normal conditions and did not present importance for the study). The clinical study results are part of the official clinical trials in the USA (ClinicalTrials.gov Identifier: NCT05256784).

Mountain products taken into consideration were part of European mountain foods. The present work considered relevant Eurostat entrepreneurship indicators (population of active enterprises for the food and accommodation sector) from Austria and some representative CEE countries such as Bulgaria, Croatia, Czech Republic, Estonia, Hungary, Latvia, Lithuania, Poland, Romania, and Slovakia (Eurostat, 2020a; 2020b; 2020c). The entrepreneurship analysis was performed from 2011 to 2019, but specific

intervals were also considered. Case studies have chosen mountain products recognised by the authorities, and detailed the entrepreneurship from the mountain region of Austria - Tyrol. Chosen mountain products and regions were representative of the CEE countries. The present work also considered that mountain entrepreneurship could offer sustainable growth solutions in this context (Pavolová *et al*., 2021).

Mountain products with high representativeness for the CEE mountain agribusiness are presented in Table 1.

Table 1. Mountain products with natural probiotic effects.

Mountain product	Therapeutic action	Therapeutic indication
P1. *Allium sativum* (garlic), *Allium cepa* L. (onion), Natural honey (melem)	Antispastic, antioxidant, cholagogue, diaphoretic, anticancer, expectorant, antipyretic, stomachic, vasodilator, antimicrobial, hypotensive, and anthelmintic	Atherosclerosis, rheumatic diseases, digestive disorders, pneumonia, flu, colds, bronchitis, asthma, cough, fever, hypertension, hypercholesterolemia, bacterial infections, osteoarthritis, intestinal parasites, gout, bloating, gastritis, diabetes, heart disorders, *Candida* vaginal discharge, acne, pityriasis, burns, skin ulcers and abscesses, vulgar warts, and COVID-19
P2. *Solanum lycopersicum* (tomato), *Capsicum* (ardei), *Cucumis sativus* (cucumber), *Daucus carota* (carrot), *Zea mays* (maize), *Cucurbita* (pumpkin)	Antioxidant, moisturizing, anti-inflammatory, astringent properties, antianemic, increases the number of red blood cells and haemoglobin, intestinal regulator, antiputrid, depurative, antispasmodic, and diuretic action	Gastrointestinal disorders, hypoacid gastritis, enterocolitis, anaemia, colibacillosis, jaundice, constipation, hypovitaminosis A, dyspeptic gastric syndrome, hydro saline retention, tuberculosis, bronchitis, asthma, asthenia, dysmenorrhea, sterility, leukaemia, diabetes mellitus, rheumatic diseases, gout, dermatitis, fatigue and pinworm, high blood pressure, arthritis, colic, low-grade fever, indigestion, bone system, tumours, regulates blood sugar and cholesterol, skin wounds, burns, acne, ulcers, itching, boils, ringworm, frostbite, and cracks
P3. *Brassica oleracea* var. Italica (broccoli), *Spinacia oleracea* (spinach), *Raphanus sativus* (radish), *Brassica oleracea* var. *capitata* (varza), *Apium graveolens* (celery), *Brassica oleracea* var. *botrytis* (cauliflower), *Beta vulgaris* (beet)	Antioxidant, anti-inflammatory, anticancer, immunity effects, anti-constipation, neural effects, anti-aging, blood pressure, depurative, antianemic, hypotensive, nutritious, remineralising, aphrodisiac and hypoglycaemic, anti-tumour, digestive, diuretic, antiasthmatic, carminative, and expectorant	Detoxification, anaemia, convalescence, demineralisation, gout, osteoporosis, thyroid disorders, kidney disease, liver detoxification and liver cell recovery, hypertension, influenza, tonsillitis, bronchitis, tuberculosis, leucorrhoea, vaginitis, trauma, haemorrhoids, contusions and periodontitis, hypertension, cough, avitaminosis, scurvy, rickets, acne, anaemia, Alzheimer, cataract, reduction of inflammation of the stomach lining, prevention of birth defects, prevention of cholesterol deposits on blood vessels including those in the brain, positive effect on muscles, anticancer properties (decreases the risk of breast cancer, prostate cancer), regulates hormone levels, kidney stones, oedema, dropsy, chronic bronchitis, asthma, albuminuria, nervousness, sterility, impotence, hypertension, obesity, demineralisation, fever, skin ulcers, and frostbite
P4. *Phaseolus vulgaris* (bean), *Solanum tuberosum* (potato)	Diuretic and protein action, hypoglycaemic, healing, emollient, antiulcer, antispasmodic, antacid, digestive calming, remineralising,	Rheumatic diseases, diabetes, obesity, hyperacidity, fever, gout, asthenia, oxyurosis, ulcer, intestinal parasites, haemorrhoids, liver disease, gastritis, hepatitis, obesity, gallstones,

	diuretic, hypotensive, and antihemorrhagic effect	glomerulonephritis, sciatica, headache, and migraine
P5. Juglans (nut)	Anti-inflammatory, antiseptic, astringent, antidiabetic and tonic-bitter, and has hypotensive, antiperspirant and healing effects	Treatment of inflammation of the oral and gastrointestinal mucosa, dyspepsia and diarrheal disorders, eczema, contact dermatitis, fungal infections, and chronic dermatitis
P6. Fungi (mushroom)	Immunomodulatory, anticancer, antiviral, detoxifying, and antifungal	Cancer, cardiovascular disease, and depression
P7. *Vaccinium vitis-idaea* (bilberry, blueberry, cranberry, lingonberry/cowberry)	Anti-inflammatory, anti-rheumatic, and antioxidant	Iron deficiency and gastrointestinal diseases, reducing the symptoms of gout, rheumatism, and inflammatory diseases, reduces sweating of the hands and feet, soothes inflammation in the throat and mouth, and lowers blood sugar
P8. *Malus pumila* (apple), *Pyrus* (pear), *Prunus* (plum), *Cerasus* (cherry), *Prunus persica* (peach)	Calming, sedative, aphrodisiac, liver protective, diuretic, depurative and urolytic effect, mild laxative, nourishing, remineralising, healing effect, moisturizes and lubricates secretions, are refreshing, anti-allergic, purifying, and detoxifying	Lubricates the lungs, lowers the mucosa and increases body fluids, heart disease, kidney, skin diseases, respiratory diseases, lowering cholesterol, intestinal disorders, gastric atony, constipation, putrefaction colitis, gout, chronic degenerative rheumatism, hypertension, depression, anxiety, growing up, pregnancy, overwork, anaemia, in febrile conditions (cold, grey), bronchitis, diabetes, skin, pyelonephritis, cystitis, nervous system diseases, and digestive diseases
P9. Dairy products (kefir, yogurt, milk, and cheese)	Antioxidant, anti-bacterial, and anti-atherogenic	Cancer, cholesterol, hepatitis, bone system, muscle system, and digestive diseases
P10. Meat (chicken, sheep, and cattle)	Cellular respiration, protein synthesis, and lipid and carbohydrate catabolism accelerate the body's reactions and produce red blood cells	skin and mucosal lesions, visual disturbances, growth and development, fatigue, hair loss, hematopoietic disorders and haemoglobin synthesis, decreases glycogen content in the liver and the body's resistance to infections, favouring the appearance of dermatological diseases
P11. Fish (trout)	Antioxidant, anti-atherogenic, and immunity effects	Multiple sclerosis, cancer, depression, memory, Alzheimer's, and eye disease

Source: Britannica (2021) and CSID (2021).

These are cultivated below 2,000 m (4th, 5th, 6th, and 7th mountain classes). Mountain class 7 includes isolated indoor basins and plateaus with less than 25 km^2 around the 6th class; the class with LER (local elevation range) > 300 m and level between 300 and 1,000 m is the 6th; the class with the slope ≥ 5° and level between 1,000 and 1,500 m is the 5th; the class with slope ≥ 2° and level between 1,500 and 2,500 m is the 4th; the class with level between 2,500 and 3,500 m is the 3rd; the class with the level between 3,500 and 4,500 m is the 2nd, and the class with the level higher than 4,500 m is the 1st (Romeo *et al*., 2015). The mountain plant resources are generally smaller than the others, but the taste and the natural probiotic effects are superior to hilly and plain areas. The present work utilised mountain products, in general, but also considered the other types of mountain food. Mountain entrepreneurship refers to all types of food, not only mountain products.

During analysis, the specific indicator was the population of active enterprises for the food and accommodation sectors. According to Eurostat, the indicator increased in Bulgaria (3.37%), Croatia (8.92%), Lithuania (51.67%), Romania (34.52%), Slovakia (1.96%), Estonia (by 12.42% from 2015 - 2017), and Poland (by 5.61% from 2016 - 2017). Other countries reduced the population of active enterprises such as Austria with -7.15%, the Czech

Republic with -6.35% (from 2013 to 2017), Hungary with -10.67% (from 2011 to 2017), and Latvia with -0.44% (from 2016 to 2017). The fluctuations presented in the CEE countries indicated the necessity of presenting the entrepreneurship from Tyrol (Austria). Tyrol, the most representative Austrian region for food and accommodation services, has counties such as Außerfern, Innsbruck, Osttirol, Tiroler Oberland, and Tiroler Unterland. As seen, not only the Austrian population of active enterprise has decreased, but their regions and counties the same, namely Tyrol (-6.04%), Außerfern (-5.63%), Innsbruck (-6.32%), Osttirol (-10.56%), and Tiroler Oberland (-2.23%).

Results

According to Regulation (E.U.) No 1151/2012 and Commission Delegated Regulation (E.U.) No 665/2014, a mountain product must meet certain conditions, such as the raw materials. The fodder for farm animals comes mainly from mountainous areas, and the processing of the products takes place in mountain areas (EU, 2012; 2014).

Rey (2014) and Ungureanu *et al*. (2020) consider mountain products food with specific criteria. Animal-based products must be obtained from animals reared for at least two-thirds of their lives in mountain areas. If the products are processed in those areas and derogation is obtained from transhumant animals, they are reared for at least a quarter of their lives. The animal feed must come mainly from mountain areas, where the proportion of the annual feed which is not from the mountain areas, expressed as a percentage of dry matter, must not exceed 50% for ruminants and 40% for pigs, and the proportion of food which cannot be produced in mountain areas, expressed as a percentage of dry matter, must not exceed 75% of their annual feed ration. The bees must collect nectar and pollen only in mountainous areas for bee products. In the case of products of plant origin, they are considered mountain products only if the plants are grown in mountain areas. Ingredients are considered mountain products even if they come from outside mountain areas, provided that they do not represent more than 50% of the total weight of the ingredients (including herbs, spices, sugar, *etc*.). Processing operations outside the mountain areas refer to products obtained from animals raised in at least the last two-thirds of their life in mountain areas if the products are processed in these areas; thus, the following processing operations may take place outside the mountain areas, provided that the distance from the mountain area concerned does not exceed 30 km - the slaughter of animals, cutting, and boning of carcasses.

The present work utilised mountain products with natural probiotic effects, a representative of CEE countries, and enumerated specific therapeutic actions and indications (Table 1). To exemplify the quality of mountain products as natural probiotics, the authors performed qualitative research for natural yogurt (animal resource) (Ijaz *et al*., 2021), *Allium sativum* - garlic (plant resource), and experimental analysis for natural honey (apicultural resource), namely honeydew (manna), which is a mountain product from Maramureș, a region of Romania, and polyfloral honey (*Tilia* - linden with mountain flowers) which is a hilly product from Moldova, a region of Romania.

Animal resources can become powerful natural probiotics against various diseases. Fermented natural dairy products are used as natural probiotics and are an extremely important component in the diet of the CEE population, especially for the rural population. The most used mountain products are yogurt or derivate products, such as kefir, ayran, *etc*. Within CEE countries, the most important species isolated from lactic bacteria fermented or raw products of dairy origin are *Lactococcus lactis*, *Leuconostoc* spp., and *Enterococcus* spp. Results showed that dairy products positively influenced the physiology of the human body. The best-known dairy products are ice cream, cheese, yogurt, and milk enriched with strains of *Acidophilus* and *Bifidus*, ayran, kefir, and kumis. Dairy drinks (fermented or unfermented) are considered foods that provide probiotics. In the fermentation process, lactic, acetic, and citric acids are naturally obtained to improve the organoleptic qualities of several products intended for consumption. According to the father of the paradigm, Elie Metchnikoff, Nobel Laureate for Medicine, yogurt is one of the most powerful probiotics, especially for the digestive system. He postulated in the famous public presentation "Old Age", held at the Society of French Agriculturalists in Paris on June 8, 1904, that the dependence between lactic acid bacteria and food makes it possible to apply methods to modify the intestinal flora by replacing bad bacteria with good ones. He suggested that yogurt bacteria prevented and annihilated intestinal bacterial infections, and likely regular

yogurt consumption prolongs life. Lactic acid bacteria would decrease the intestinal pH, which stops the proliferation of various proteolytic bacterial species. Metchnikoff popularised yogurt in Europe as a functional food with health benefits (Rusu and Cojocaru, 2014).

Regarding plant resources, CEE countries are specialised in using different plants as natural probiotics. The commonly used plant resource is *Allium sativum* (garlic). As a natural probiotic, garlic consumption is just as old in the CEE as in many other countries worldwide. Garlic is listed in the Dietary Guide for Americans 2015 - 2020. Garlic intake variants (capsules, aqueous extract, old alcoholic extract, *etc.*) are not very popular in the CEE, as they prefer raw garlic (Ionescu, 2020).

The most important natural garlic extract is aged garlic extract. Garlic contains high phosphorus, potassium, sulphur, and zinc; moderate selenium, vitamins A and C; and low calcium, magnesium, sodium, iron, manganese, and B-complex vitamins. In addition, many compounds have been identified and isolated from garlic extracts, including 33 sulphur compounds and 17 amino acids, which include alanine (2-aminopropanoic acid), arginine (2-amino-5-guanidinopentanoic acid), aspartic acid (2-aminobutanedioic acid), asparagine (2-amino-3-carbamoylpropanoic acid), histidine (2-amino-3-(1H-imidazol-4-yl) propanoic acid), leucine (2-amino-4-methylpentanoic acid), methionine (2-amino-4-(methylthio) butanoic acid), phenylalanine ((S)-2-amino-3-phenylpropanoic acid), proline (pyrrolidine-2-carboxylic acid), serine (2-amino-3-hydroxypropanoic acid), threonine (2-amino-3-hydroxybutanoic acid), tryptophan (tryptophan or (2S)-2-amino-3-(1H-indol-3-yl) propanoic acid), and valine (2-amino-3-methylbutanoic acid) (Agarwal, 1996). Glutathione ((2S)-2-amino-5-({(2R)-1-[(carboxymethyl) amino]-1-oxo-3-sulfanylpropan-2-yl} amino) -5-oxopentanoic acid / γ-L-glutamyl-L-cysteinylglycine (2S) -2-amino-4- ({(1R)-1-[(carboxymethyl) carbamoyl]-2-sulfanylethyl} carbamoyl) butanoic acid) is produced by human and animal organisms to get rid of toxins. It binds free radicals to eliminate them, depending on glutathione concentration in the body. It is known that chronic diseases generally reduce glutathione content in the body. Selenium is part of an enzyme that produces glutathione, and it is crucial to consume foods containing glutathione (Otitoju and Onwurah, 2007).

Natural honey, one of the most complex food and probiotics, contains approximatively 200 substances. Natural bee honey contains flavonoids (such as apigenin (5,7-dihydroxy-2-(4-hydroxyphenyl)-4H-1-benzopyran-4-one), pinocembrin (5,7-dihydroxy-2-phenyl-2,3-dihydro-4H-chromen-4-one / 4H-1-benzopyran-4-one, 2,3-dihydro-5,7-dihydroxy-2-phenyl-5,7-dihydroxy-2-phenyl-chroman-4-one, kaempferol (3,5,7-trihydroxy-2-(4-hydroxyphenyl)-4H-1-benzopyran-4-one), quercetin (2-(3,4-dihydroxyphenyl)-5,7-dihydroxy-4H-1-benzopyran-4-one), galangin (3,5,7-trihydroxy-2-phenyl-4H-1-benzopyran-4-one), chrysin (5,7-dihydroxy-2-phenyl-4H-1-benzopyran-4-one), and hesperetin ((2S)-5,7-dihydroxy-2-(3-hydroxy-4-methoxyphenyl)-2,3-dihydro-4H-1-benzopyran-4-one)). Phenolic acids (such as ellagic (2,3,7,8-tetrahydroxy[1]benzopyrano[5,4,3-cde][1]benzopyran-5,10-dione), caffeic ((2E)-3-(3,4-dihydroxyphenyl)prop-2-enoic acid), *p*-coumaric ((2E)-3-(4-hydroxyphenyl)prop-2-enoic acid), ferulic acids ((2E)-3-(4-hydroxy-3-methoxyphenyl)prop-2-enoic acid)), catalase (CAT), ascorbic acid (l-ascorbic acid), and superoxide dismutase (SOD) reduced glutathione (GSH), Maillard reaction products, tocopherols (α-tocopherol), and peptides. These compound works together to provide a synergistic antioxidant effect (Eteraf-Oskouei and Najafi, 2013).

Following Romanian Research-Development National Institute for Apiculture - Bulletin Analysis 39/29.01.2021, the present work showed that both types of natural honey had the same diastase index, 29.4 ± 0.18 unit on Goethe; mountain honey had sucrose (β-D-fructofuranosyl α-D-glucopyranoside) of 2.41 ± 0.43% (g/g), while hilly products had 2.19 ± 0.39 % (g/g); reducing sugar was in percent of 76.18 ± 3.40% (g/g), and to the other 75.67 ± 3.37% (g/g). 5-hydroxymethylfurfural had a value of 0.10 ± 0.01 mg/100 g of honey for the mountain product, and 0.19 ± 0.03 mg/100 g of honey for the hilly product; mountain honey had a higher pH value of 3.00 ± 0.46 mL sodium hydroxide solutions 1 N/100 g of honey and the other of 2.80 ± 0.43 mL sodium hydroxide solutions 1 N/100 g of honey; moisture contents were 17.20 ± 0.24% (g/g) for the mountain product and 16.80 ± 0.24% (g/g) for the other type of honey; pollen analysis presented percentages of 98% of manna and 2% of mountain polyfloral for the mountain product, and of 95% of linden and 5% of manna for the other type of mountain; electrical

conductivity presented a value of 0.55 mS/cm, while ashes were in the value of 0.21 ± 0.02% (g/g) (mountain product) and 0.44 ± 0.03% (g/g) (hilly product); fructose (3S,4R,5R)-1,3,4,5,6-pentahydroxyhexan-2-one) presented a percentage of 41.06% (g/g) (mountain honey), 40.10% (g/g) (hilly honey), glucose (2R,3S,4R,5R)-2,3,4,5,6-pentahydroxyhexanal) a percentage of 35.12% (g/g) (mountain product), and 35.57% (g/g) (hilly product). The physicochemical analysis showed that the mountain honey is of higher quality than the hilly honey. Honeydew contains many minerals (calcium, magnesium, iron, potassium, phosphorus, and selenium), antioxidants, organic acids, bioflavonoids, vitamins (especially C and group B), inhibin (strong bactericide), and enzymes. Minerals, proteins, and some acids in mountain honey are five to ten times higher than hilly honey.

Clinical studies (C.S.) and survival analysis performed in the present work showed that the tested subjects' immunity improved following the mountain product consumption (Tables 2, 3, 4, and 5). Regarding yogurt consumption, the influence on human immunity present considerable values of magnesium, vitamin D, leukocyte, mean corpuscular haemoglobin, average haemoglobin / erythrocyte concentration, lymphocyte, monocyte, eosinophilic, basophil, and zinc (C.S. 1 - Table 2). Different studies confirmed the positive influence of yogurt consumption on immunity, namely Ajibola *et al*. (2012), Asemi *et al*. (2012), Jafari *et al*. (2016), Leonard (2018), Gasparri *et al*. (2019), Kim *et al*. (2020), Yang *et al*. (2022), and Ravindran *et al*. (2022). *Allium sativum* (garlic) positively influences the immunity of the organism, modifying the values of vitamin D, erythrocyte distribution width, platelets and platelet distribution width, neutrophil, monocyte, and zinc (C.S. 2 and 3 - Tables 3 and 4). The influence of garlic on immunity is confirmed by numerous studies such as Oluwole (2001), Hodge *et al*. (2002), Mukherjee *et al*. (2006), Hamlaoui-Gasmi *et al*. (2012), Samson *et al*. (2012), Gholipour Kanani *et al*. (2014), Ried and Fakler (2014), Percival (2016), Divya *et al*. (2017), Champagne *et al*. (2018), Eor *et al*. (2020), Lee *et al*. (2020), Bandyopadhyay (2021), Singh *et al*. (2021), *etc*. Natural honey, especially manna honey, is considered one of the most powerful human immunity foods. Based on our clinical analysis, mountain honey had a positive effect on the adjustment of calcium, magnesium, vitamin B_{12}, vitamin B_9, vitamin D, mean corpuscular haemoglobin (MCH), average Hgb / erythrocyte concentration, erythrocyte distribution width, platelets, lymphocyte, monocyte, and eosinophilic (C. S. 4 - Table 5). Complex research, clinical, and experimental works highlighted the importance of natural honey in immunodeficiency such as those by George Kitzes and Schuette Elvehjem (1943), Al-Waili (2003), Ahmed *et al*. (2011), Sell *et al*. (2012), Abdulrhman (2018), Attia *et al*. (2022), Bakour *et al*. (2022), Martínez-Puc *et al*. (2022), and Ismail *et al*. (2022).

Regarding the presented benefits of the mountain foods/products, CEE entrepreneurs are financed to develop their businesses in the mountain area. During the analysis period, according to Eurostat, the countries with the highest growth of entrepreneurship in the field of accommodation and food services from the CEE area are the Czech Republic (58,085 units in 2017), Poland (82,147 units in 2017), and Romania (37,926 units in 2017). Regarding mountain entrepreneurship, Eurostat data present significant value modifications for the population of active enterprises of the CEE countries in the analysed period, followed by Bulgaria (4.24%), Czech Republic (11.73%), Croatia (14.91%), Austria (13.03%), Poland (5.27%, 2016/2017), Romania (9.61%), and Slovakia (7.94%). Even Austria presents an insignificant reduction of the population of active enterprises index for the 2008 - 2017 period, but still representing an example for the CEE countries. Austria's local consumers and visitors understand the importance of consuming healthy and nutritional food. Consequently, they pay more for mountain food with natural probiotic effects.

Discussion

As described in Table 1, mountain products are grouped in conformity with the main actions on human and animal immunity. Based on experimental and clinical analysis of the present work, Luang-In *et al*. (2021) and Britannica (2021), the mountain products mentioned as natural probiotics are fighting against different bacteria, fungi, viruses, and pathogens such as SARS-CoV-2, *Enterobacteriaceae* with *Escherichia coli* and *Klebsiella pneumoniae*, *Pseudomonas aeruginosa*, *Staphylococcus aureus*, *Enterococcus*, *Staphylococcus aureus*, *Enterococcus faecalis*, *Escherichia coli*, *Pseudomonas aeruginosa*, and (P1, Table 1); *Serratia marcescens*, *Micrococcus*

Table 2. C.S. 1 - male of 44 years, consumption of mountain yogurt.

Name and method of analysis	Result 26.01.2022	Result 11.03.2022	Reference interval
Serum calcium Serum / colorimetric method / spectrophotometry	10.1	9.9	8.6 - 10 (mg/L)
Serum magnesium Serum / colorimetric method / spectrophotometry	2.13	2.22	1.6 - 2.6 (mg/L)
Serum iron (sideremia) Serum / colorimetric method / spectrophotometry	169	128	37 - 145 (µg/dL)
Vitamin B_{12} Serum/ECLIA	602	582	197 - 771 (pg/mL)
Serum folate Serum / ECLIA - electrochemiluminescent	9	7.1	4.6 - 34.8 (ng/mL)
25-OH-vitamin D Serum / electrochemiluminescent	15.8	19.2	deficiency < 20; insufficient 21 - 29 optimum 30 - 55.5 (ng/mL)
Blood count with leukocyte formula with Hb, Ht, and indices Blood EDTA / methods: hydrodynamic focusing, flow cytometry, SLS-Hb			
Leukocyte number	5.67	5.99	4 - 10 (tsd/µL)
Erythrocytes number	4.97	4.8	3.8 - 5.1 (mil./µL)
Haemoglobin {Hgb}	15.4	15	11.7 - 15.5 (g/dL)
Haematocrit	44.1	42.3	35 - 45 (%)
Medium erythrocyte volume {MEV}	88.7	88.1	81 - 100 (fL)
Mean corpuscular haemoglobin {MCH}	31	31.3	27 - 34 (pg/cell)
Average Hgb / erythrocyte concentration	34.9	35.5	32 - 36 (g/dL)
Erythrocyte distribution width	11.9	11.8	11.6 - 14.8 (%)
Platelets number	300	292	150 - 450 (tsd/µL)
Average platelet volume {APM}	11.2	10.8	7.4 - 13 (fL)
Platelet distribution width	13.7	13.5	8 - 16.5 (fL)
Neutrophil	49.7	42.3	45 - 80 (%)
Neutrophil	2.82	2.53	2 - 8 (tsd/µL)
Lymphocyte	40.7	46.9	20 - 55 (%)
Lymphocyte	2.31	2.81	1 - 4 (tsd/µL)
Monocyte	7.8	8.8	≤ 15 (%)
Monocyte	0.44	0.53	0.3 - 1 (tsd/µL)
Eosinophilic	1.1	1.2	≤ 7 (%)
Eosinophilic	0.06	0.07	0.05 - 0.7 (tsd/µL)
Basophil	0.7	0.8	≤ 2 (%)
Basophil	0.04	0.05	≤ 0.2 (tsd/µL)
Zinc in the blood Blood EDTA / inductively coupled plasma with mass spectrometry (ICP / MS)	5	5.2	4.5 - 7.5 (mg/L)

Based on Synevo analysis.

Table 3. C.S. 2 - female of 44 years, consumption of mountain garlic.

Name and method of analysis	Result 26.01.2022	Result 11.03.2022	Reference interval
Serum calcium Serum / colorimetric method / spectrophotometry	9.6	9.5	8.6 - 10 (mg/dL)
Serum magnesium Serum / colorimetric method / spectrophotometry	2.25	2.2	1.6 - 2.6 (mg/dL)
Serum iron (sideremia) Serum / colorimetric method / spectrophotometry	168	146	37 - 145 (µg/dL)
Vitamin B_{12} Serum / ECLIA	307	273	197 - 771 (pg/mL)
Serum folate Serum / ECLIA - electrochemiluminescent	9.4	8.6	4.6 - 34.8 (ng/mL)
25-OH-vitamin D Serum / electrochemiluminescent	8.23	9.5	deficiency < 20; insufficient 21 - 29 optimum 30 - 55.5 (ng/mL)
Blood count with leukocyte formula with Hb, Ht and indices			
Blood EDTA / methods: hydrodynamic focusing, flow cytometry, SLS-Hb			
Leukocyte number	8.19	7.41	4 - 10 (tsd/µL)
Erythrocytes number	4.31	4.21	3.8 - 5.1 (mil./µL)
Haemoglobin {Hb}	14.2	13.4	11.7 - 15.5 (g/dL)
Haematocrit	41.3	40.1	35 - 45 (%)
Medium erythrocyte volume {MEV}	95.8	95.2	81 - 100 (fL)
Mean corpuscular haemoglobin {MCH}	32.9	31.8	27 - 34 (pg/cell)
Average Hgb / erythrocyte concentration	34.4	33.4	32 - 36 (g/dL)
Erythrocyte distribution width	12.1	12.2	11.6 - 14.8 (%)
Platelets number	65	93	150 - 450 (tsd/µL)
Average platelet volume {APM}	10.8	10.6	7.4 - 13 (fL)
Platelet distribution width	11.3	11.8	8 - 16.5 (fL)
Neutrophil	61.1	63.5	45 - 80 (%)
Neutrophil	5.01	4.7	2 - 8 (tsd/µL)
Lymphocyte	26	23.6	20 - 55 (%)
Lymphocyte	2.13	1.75	1 - 4 (tsd/µL)
Monocyte	10.3	10.5	≤ 15 (%)
Monocyte	0.84	0.78	0.3 - 1 (tsd/µL)
Eosinophilic	2.1	1.9	≤ 7 (%)
Eosinophilic	0.17	0.14	0.05 - 0.7 (tsd/µL)
Basophil	0.5	0.5	≤ 2 (%)
Basophil	0.04	0.04	≤ 0.2 (tsd/µL)
Zinc in the blood Blood EDTA / inductively coupled plasma with mass spectrometry (ICP / MS)	5.5	5.6	4.5 - 7.5 (mg/L)

Based on Synevo analysis.

Table 4. C.S. 3 - male of 73 years, consumption of mountain garlic.

Name and method of analysis	Result 26.01.2022	Result 09.03.2022	Reference interval
Serum calcium Serum / colorimetric method / spectrophotometry	9.45	9.78	8.6 - 10 (mg/L)
Serum magnesium Serum / colorimetric method / spectrophotometry	2.20	2.20	1.6 - 2.6 (mg/L)
Serum iron (sideremia) Serum / colorimetric method / spectrophotometry	72.54	95.40	37 - 145 (µg/dL)
Vitamin B_{12} Serum / ECLIA	299	252	197 - 771 (pg/mL)
Serum folate Serum / ECLIA – electrochemiluminescent	2.4	4.1	4.6 - 34.8 (ng/mL)
25-OH-vitamin D Serum / electrochemiluminescent	8.9	12.7	deficiency < 20; insufficient 21 - 29 optimum 30 - 55.5 (ng/mL)
Blood count with leukocyte formula with Hb, Ht and indices			
Blood EDTA / methods: hydrodynamic focusing, flow cytometry, SLS-Hb			
Leukocyte number	7.12	8.04	4 - 10 (tsd/µL)
Erythrocytes number	5.38	5.32	3.8 - 5.1 (mil./µL)
Haemoglobin {Hb}	16.1	16.0	11.7 - 15.5 (g/dL)
Haematocrit	49.0	48,2	35 - 45 (%)
Medium erythrocyte volume {MCV}	91.1	90.6	81 - 100 (fL)
Mean corpuscular haemoglobin {MCH}	29.9	30.1	27 - 34 (pg/cell)
Average Hgb / erythrocyte concentration	32.9	33.2	32 - 36 (g/dL)
Erythrocyte distribution width	11.7	11.9	11.6 - 14.8 (%)
Platelets number	202	233	150 - 450 (tsd/µL)
Average platelet volume {MPV}	9.8	9.6	7.4 - 13 (fL)
Platelet distribution width	11.7	10.7	8 - 16.5 (fL)
Neutrophil	64.8	58.4	45 - 80 (%)
Neutrophil	4.61	4.70	2 - 8 (tsd/µL)
Lymphocyte	21.1	25.9	20 - 55 (%)
Lymphocyte	1.50	2.08	1 - 4 (tsd/µL)
Monocyte	11.2	12.6	≤ 15 (%)
Monocyte	0.80	1.01	0.3 - 1 (tsd/µL)
Eosinophilic	2.5	2.7	≤ 7 (%)
Eosinophilic	0.18	0.22	0.05 - 0.7 (tsd/µL)
Basophil	0.4	0.4	≤ 2 (%)
Basophil	0.03	0.03	≤ 0.2 (tsd/µL)
Zinc in the blood Blood EDTA / inductively coupled plasma with mass spectrometry (ICP / MS)	5.5	6.6	4.5 - 7.5 (mg/L)

Based on Synevo analysis.

Table 5. C.S. 4 - female of 77 years, consumption of mountain honey.

Name and method of analysis	Result 26.01.2022	Result 09.03.2022	Reference interval
Serum calcium Serum / colorimetric method / spectrophotometry	9.36	9.69	8.6 - 10 (mg/dL)
Serum magnesium Serum / colorimetric method / spectrophotometry	2.15	2,25	1.6 - 2.6 (mg/dL)
Serum iron (sideremia) Serum / colorimetric method / spectrophotometry	80.61	79,02	37 - 145 (µg/dL)
Vitamin B_{12} Serum / ECLIA	474	498	197 - 771 (pg/mL)
Serum folate Serum / ECLIA - electrochemiluminescent	5.2	9	4.6 - 34.8 (ng/mL)
25-OH-vitamin D Serum / electrochemiluminescent	8.1	10	deficiency < 20; insufficient 21-29 optimum 30 - 55.5 (ng/mL)
Blood count with leukocyte formula with Hb, Ht and indices			
Blood EDTA / methods: hydrodynamic focusing, flow cytometry, SLS-Hb			
Leukocyte number	5.69	5,51	4 - 10 (tsd/µL)
Erythrocytes number	4.59	4,37	3.8 - 5.1 (mil./µL)
Haemoglobin {Hb}	14.2	13.6	11.7 - 15.5 (g/dL)
Haematocrit	43.1	41.0	35 - 45 (%)
Medium erythrocyte volume {MEV}	93.9	93.8	81 - 100 (fL)
Mean corpuscular haemoglobin {MCH}	30.9	31.1	27 - 34 (pg/cell)
Average Hgb / erythrocyte concentration	32.9	33,2	32 - 36 (g/dL)
Erythrocyte distribution width	13.1	13.3	11.6 - 14.8 (%)
Platelets number	278	290	150 - 450 (tsd/µL)
Average platelet volume {APM}	10.6	10.1	7.4 - 13 (fL)
Platelet distribution width	12.6	11.1	8 - 16.5 (fL)
Neutrophil	57.3	55.04	45 - 80 (%)
Neutrophil	3.26	3.05	2 - 8 (tsd/µL)
Lymphocyte	27.9	29.0	20 - 55 (%)
Lymphocyte	1.51	1.60	1 - 4 (tsd/µL)
Monocyte	12.7	13.04	≤ 15 (%)
Monocyte	0.78	0.74	0.3 - 1 (tsd/µL)
Eosinophilic	1.6	1.8	≤ 7 (%)
Eosinophilic	0.09	0.1	0.05 - 0.7 (tsd/µL)
Basophil	0.5	0.4	≤ 2 (%)
Basophil	0.03	0.02	≤ 0.2 (tsd/µL)
Zinc in the blood Blood EDTA / inductively coupled plasma with mass spectrometry (ICP / MS)	5.6	5.7	4.5 - 7.5 (mg/L)

Based on Synevo analysis.

luteus, *Streptococcus pyrogenes*, *Pseudomonas aeruginosa* and *Bacillus cereus* (P2, Table 1); pathogenic bacteria, phytopathogenic moulds and yeasts, *Staphylococcus aureus* and *Bacillus cereus*, *Staphylococcus epidermidis*, *Citrobacter freundii*, *Salmonella typhymurium*, and *Staphylococcus cohni* (P3, Table 1); *Fusarium* sp., *Macrophomina* sp., *Alternaria* sp., *Bacillus amyloliquefaciens*, *Bacillus halotolerans*, *Bacillus velezensis*, *Agrobacterium fabrum*, and *Pseudomonas lini* (P4, Table 1); *Escherichia coli*, *Staphylococcus aureus*, *Klebsiella* spp., *Pseudomonas aeruginosa*, *Enterococcus faecalis*, coagulase-negative staphylococci, *Enterobacter* spp., *Enterococcus faecium*, *Proteus* spp., *Candida albicans*, Herpes simplex virus type 1 and 2, Poliovirus 1, Adenovirus 2, Echovirus 9, and Coxsackievirus B1 (P5, Table 1); SARS-CoV-2, *Enterococcus faecium*, *Staphylococcus aureus*, *Klebsiella pneumoniae*, *Acinetobacter baumannii*, *Pseudomonas aeruginosa*, *Enterobacter* species, and *Escherichia coli* (P6, Table 1); *Actinobacillus actinomycetemcomitans*, *Porphyromonas gingivalis*, and *Prevotella intermedia* (P7, Table 1), *Bacillus subtilis*, *B. cereus*, *Staphylococcus aureus*, *Listeria monocytogenes*, *Salmonella typhimurium*, and *Escherichia coli* (P8, Table 1); *Listeria monocytogenes*, *Salmonella* spp., *Staphylococcus* aureus, and pathogenic *Escherichia coli* (P9, Table 1); and SARS-CoV-2 (P10 and P11, Table 1) (Luang-In *et al*., 2021; Britannica, 2021).

The Austrian Tyrol represents a model of CEE countries due to its geographical (mountain regions, predominantly rural areas) and socio-economic conditions. Austrian population of active enterprises decreased between 2008 and 2017 by 4130 units (from 57,726 units to 53,596). The trend was similar in Tyrol - the region with the highest mountain potential in Austria. However, Tyrol only decreased by 688 units (from 11,394 to 10,706 units).

Mountain entrepreneurship increased in the CEE countries between 2008 and 2018, and the forecasting model for 2050 shows an important growth in the next years (Figure 1). Outlook for 2050 shows that Bulgaria, Croatia, Romania, and Slovakia will have strong linear growth as far as 2050, Czech will have slow growth, while Austria and Poland will decrease in growth. However, based on the idea of mountain foods as a natural probiotic, all countries' financial results are positive, including Austria and Poland. In this sense, food consumers should be allowed to know whether the foods they consume have added values. Food and taste preferences must offer the possibility to choose between consciousness and desire, special and usual, and intentional and accidental (Macková *et al*., 2019).

In 2050, mountain agriculture will have a major organic farming role. The major share of mountain farms will be managed based on organic farming rules, and certified as mountain products, organic products, and other labels. Mountain products will have recognised the high-quality value and represent a niche product model.

CEE is involved in mountain agriculture; Austria represents the leadership model in mountain food. Mountain agriculture has a crucial role in developing traditional values, harmonious landscape, specific breeds and species, sustaining specific culture, heritage, and adequate techniques (Hojesky *et al*., 2019).

Conclusion

Based on the experimental and clinical research of the paper, CEE mountain products support human immunity, and act as natural probiotics, especially in the context of COVID-19 realities. CEE countries' superior nutritional properties of mountain products make them competitive in several economic branches such as entrepreneurship, regular and medicinal tourism, and agribusiness. Austria offers more qualitative services and food behaviours, and geographically is surrounded by CEE countries, therefore being a model for the other economies.

Re-evaluation and application of healthy behaviour in agro-food and service models, transitioning from one pattern to another, must be performed from individual (private) to general (public), but through the massive involvement of public decision-makers in the proper agribusiness (Kubicová *et al*., 2019; Gołaś, 2020).

From a nutritional point of view, mountain products act as natural probiotics. From a socio-economic point of view, people are constrained to certain types of agro-food and services behaviours - depending on what is cheaper and more on the shelf or simply accessibility of the products to the people. Mountain entrepreneurs from food and services from CEE countries should re-evaluate their business paradigm to overcome these issues.

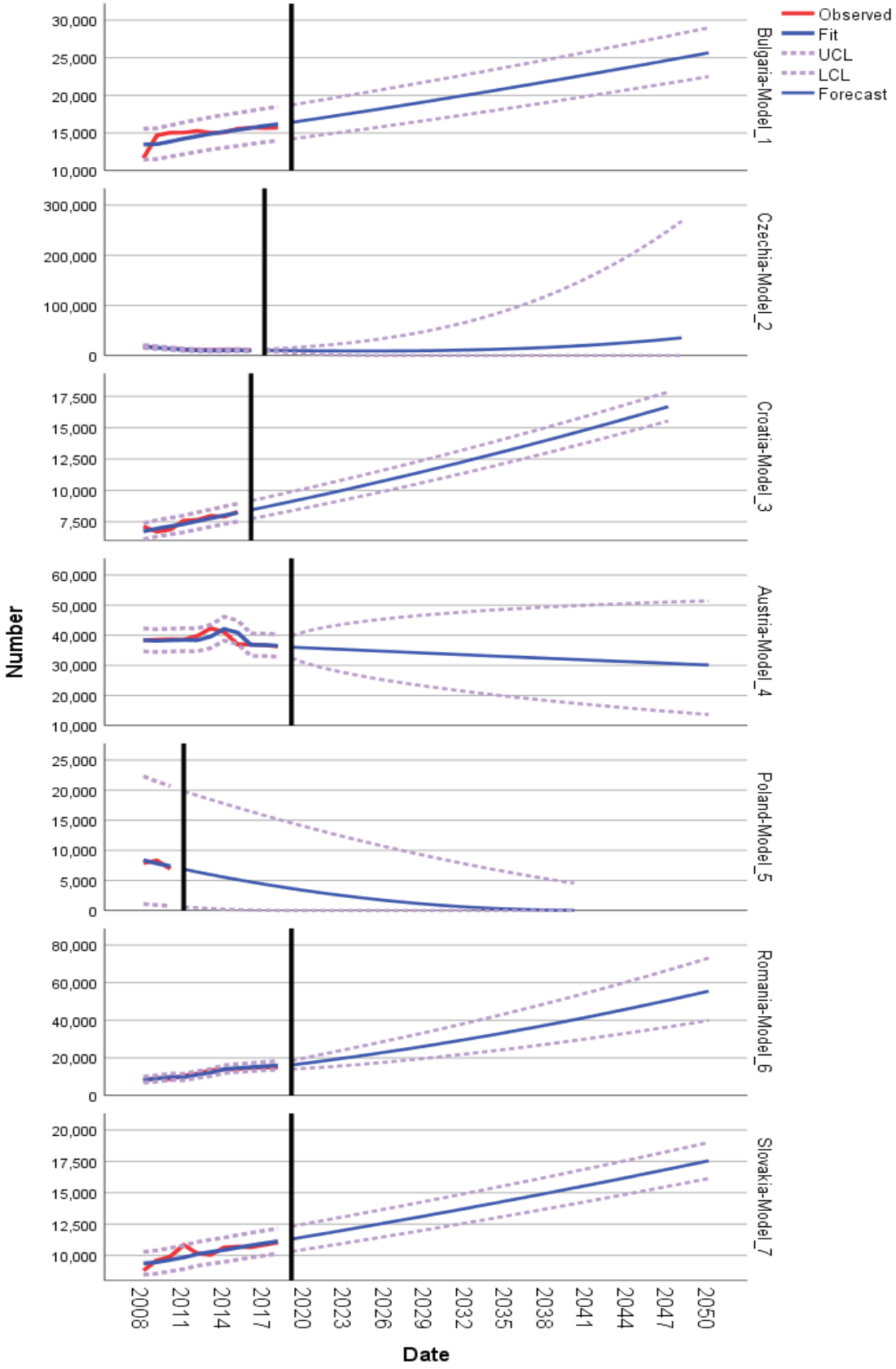

Figure 1. Mountain entrepreneurship between 2008 and 2050.
Source: Eurostat - Business Demography Statistics.

In the CEE countries, mountain entrepreneurship for the studied indices increased considerably, but without considering the context of eating behaviour and services, which were performed under normal conditions. Specific for Romania, especially the North-East region, the business carried out within the active enterprises from the secondary and tertiary sectors (except for the agriculture sector) can represent the development engine of this area. The multitude of active enterprises, especially the quality and added value they give to the local economy, leads to an increase in the population's living standard and well-being. In this sense, governmental actions are required, especially local ones, to develop entrepreneurship. A considerable potential is represented by the mountain area, where the primary products have high-quality value. The local and central measures developed must consider some of the results of the present work.

The multitude of active enterprises, especially the quality and added value given to the local economy, increases the living standards and population well-being. In this sense, governmental actions, especially local ones, are required to develop mountain entrepreneurship. A considerable potential is represented by the mountain area, where the primary products have high-quality value. The local and central measures developed must consider some of the results of the present work.

Although the degree of mountain entrepreneurship decreased in Austria in numerical volume, the economic growth remained, and the financial volume increased considerably. The economic momentum in Austria, especially in Tyrol, has been achieved through high-quality mountain services and products. The expansion was based on the real economy in Austria, not underfunded through European funds or other volatile schemes and funds. CEE countries should understand the Austrian mountain entrepreneurship and apply it to their economies.

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