

APPLICATIONS OF SUPERCRITICAL FLUIDS IN LATIN AMERICA: PAST, PRESENT, AND FUTURE TRENDS

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Abstract. Latin America (LA) is formed by 33 countries: Antigua and Barbuda, Argentina (AR), Bahamas, Barbados, Belize, Bolivia (BO), Brazil (BR), Chile (CH), Colombia (CO), Commonwealth of Dominica, Costa Rica, Cuba, Dominican Republic, Ecuador, El Salvador, Granada, Guatemala, Guyana, Haiti, Honduras, Jamaica, Mexico, Nicaragua, Panama, Paraguay (PA), Peru (PE), Saint Kitts, Saint Vincent and the Grenadines, Santa Lucia, Suriname, Trinidad and Tobago, Uruguay, and Venezuela. Supercritical fluids have found applications as reported by scientist from these countries. Therefore, in this work, a review of the Latin-America scientific production in the field of supercritical fluid is presented. A search was done using the term ‘supercritical fluid*’ and requiring the presence of one of the 33 countries listed above in the address field. In the past 7 years (2006 – 2013) 394 papers were published in Journals indexed in ISI Web of Knowledge data basis; in the past 3 years (2010 – 2013) as many as 191 papers were published with the participation of Latin-American scientists. This is more than twice the production of South American countries in the 5 years period comprised from 1999 – 2003: 82 papers from South American countries were published in journals indexed in the Web of Science data basis. Of these, 26 papers were related to the use of SCF as an analytical tool. Supercritical extraction from a variety of vegetable raw material contributed with 38 papers and SFE applied to the petroleum industry added 2 papers to the field. Reactions contributed with 3 publications while thermodynamics and fundamental studies were responsible for 13 publications. A compilation done in 2008 of papers published by Latin-America scientist showed that extractions, thermodynamics, reactions, analytical applications, and so on are among the applications of supercritical fluids; the leading applications were related to extraction of bioactive compounds from a variety of biological matrices. New applications of supercritical fluids were reported in literature by Latin-American scientists such as polymerization reactions, hydrolyzes of bioresidues, enzymatic reactions, gas sensors, micronization and particle formation to mention only few of them.

Keywords: Supercritical fluids, SFE, polymerization reactions, hydrolyzes of bioresidues, enzymatic reactions, gas sensors, micronization, particle formation.

1. Introduction

Researches done in Latin America have been responsible for 2.5% of the worldwide publications in supercritical technology area until 2010. In the past three years (2010-2013), the efforts done by the Latin-American scientists and the new applications of supercritical fluids expanded the Latin America contribution up to 4.8% of the worldwide publications. To evaluate the importance of processes involving supercritical fluids in obtaining value-added products, the investigations performed in the related countries were classified into nine groups: extraction, analytical applications, fundamental and thermodynamic studies, energy applications, reactions in supercritical fluids, materials and micronization, review and perspectives, petroleum applications and economics. This classification and the participation of six countries (Argentina, Brazil, Chile, Colombia, México and Uruguay) are presented in Table 1.

Table 1. Summary of the studies developed in Latin America from 2010-2013

Country	Group of study	Article Title	Year	Ref.
ARGENTINA	Analytical applications	Sorption and diffusion of compressed carbon dioxide in polycaprolactone for the development of porous scaffolds	2012	[1]
		Proton transfer from 2-naphthol to aliphatic amines in supercritical CO ₂	2011	[2]
	Energy applications	Ketalization of glycerol to solketal in supercritical acetone	2011	[3]
		Fractionation of essential oils with biocidal activity using supercritical CO ₂ -experiments and modeling	2011	[4]
	Fundamental & thermodynamic studies	Critical effects on attractive solutes in binary liquid mixtures close to their consolute point: a new experimental strategy	2011	[5]
		AVA seismic reflectivity analysis in carbon dioxide accumulations: sensitivity to CO ₂ phase and saturation	2011	[6]
		Computation of solid-fluid-fluid equilibria for binary asymmetric mixtures in wide ranges of conditions	2011	[7]
		Equation of state modeling of the phase equilibria of asymmetric CO ₂ + n-alkane binary systems using mixing rules cubic with respect to mole fraction	2010	[8]
		Near-critical and supercritical dilute solutions viewed from macroscopic and molecular-scale perspectives	2010	[9]
		Experimental cloud points for polybutadiene plus light solvent and polyethylene plus light solvent systems at high pressure	2010	[10]
		Isochoric lines and determination of phase transitions in supercritical reactors	2010	[11]
	Materials and micronization	Precipitation and encapsulation of rosemary antioxidants by supercritical antisolvent process	2012	[12]
		Supercritical CO ₂ fractionation of rosemary ethanolic oleoresins as a method to improve carnosic acid recovery	2011	[13]
	Reactions in supercritical fluids	Grafting of styrene onto polyethylene in near critical media	2012	[14]
	Review and perspectives	Optimizing design in open channel	2010	[15]
BRAZIL	Analytical applications	Single laboratory validation of a SPE method for the determination of PAHs in edible oils by GC-MS	2012	[16]
		Supercritical adsorption of buriti oil (<i>Mauritia flexuosa</i> Mart.) in gamma-alumina: A methodology for the enriching of antioxidants	2012	[17]
		Effects of supercritical carbon dioxide on waste banana peels for heavy metal removal	2011	[18]
		SFE from <i>Bidens pilosa</i> Linne to obtain extracts rich in cytotoxic polyacetylenes with antitumor activity	2011	[19]
		Biological activities of <i>Solanum paludosum</i> Moric. extracts obtained by maceration and supercritical fluid extraction	2011	[20]
Supercritical carbon dioxide selectivity to fractionate phenolic compounds from the dry ethanolic extract of propolis	2010	[21]		

Table 1. Continued

Economics	Supercritical anti-solvent precipitation of carotenoid fraction from pink shrimp residue: Effect of operational conditions on encapsulation efficiency	2012	[22]	
	Manufacturing cost of supercritical-extracted oils and carotenoids from amazonian plants	2010	[23]	
Energy applications	Preliminary studies on advanced power generation based on combined cycle using a single high-pressure fluidized bed boiler and consuming sugar-cane bagasse	2012	[24]	
	Sustainable energy: A review of gasification technologies	2012	[25]	
BRAZIL	Radical-scavenging activity of extracts from <i>Cordia verbenacea</i> DC obtained by different methods	2011	[26]	
	Supercritical extraction from vinification residues: Fatty acids, alpha-tocopherol, and phenolic compounds in the oil seeds from different varieties of grape	2012	[27]	
	Supercritical extraction of linseed oil: economical viability and modeling extraction curves	2013	[28]	
	Extracts from the leaves of <i>Piper piscatorum</i> (Trel. Yunc.) obtained by supercritical extraction of with CO ₂ , employing ethanol and methanol as co-solvents	2013	[29]	
	Extraction from striped weakfish (<i>Cynoscion striatus</i>) wastes with pressurized CO ₂ : Global yield, composition, kinetics and cost estimation	2012	[30]	
	Defatting of annatto seeds using supercritical carbon dioxide as a pretreatment for the production of bixin: experimental, modeling and economic evaluation of the process	2012	[31]	
	Extraction of <i>Mentha spicata</i> L. Volatile compounds: Evaluation of process parameters and extract composition	2012	[32]	
	Extraction	Supercritical fluid extraction from spent coffee grounds and coffee husks: Antioxidant activity and effect of operational variables on extract composition	2012	[33]
	HPLC analysis of supercritical carbon dioxide and compressed propane extracts from <i>Piper amalago</i> L. with antileishmanial activity	2012	[34]	
	Extraction, fatty acid profile and antioxidant activity of sesame extract (<i>Sesamum Indicum</i> L.)	2012	[35]	
	Characteristics of the extract of <i>Litopenaeus vannamei</i> shrimp obtained from the cephalothorax using pressurized CO ₂	2012	[36]	
	HPLC analysis and antileishmanial activity of supercritical fluids extracts from <i>Piper amalago</i> L	2012	[37]	
	Supercritical fluid extraction of hernandulcin from <i>Lippia dulcis</i> Trev	2012	[38]	
	Extraction of Mucuna seed oil using supercritical carbon dioxide to increase the concentration of L-Dopa in the defatted meal	2012	[39]	
Supercritical fluid extraction of <i>Agaricus brasiliensis</i> : Antioxidant and antimicrobial activities	2012	[40]		
Supercritical fluid extraction from guava (<i>Psidium guajava</i>) leaves: global yield, composition and kinetic data	2012	[41]		

Table 1. Continued

BRAZIL	Extraction	Effect of storage time and conditions on the diene valepotriates content of the extract of valeriana glechomifolia obtained by supercritical carbon dioxide	2012	[42]
		The antitumor activity of extracts from <i>Cordia verbenacea</i> DC obtained by supercritical fluid extraction	2012	[43]
		Supercritical fluid extraction of grape seed: Process scale-up, extract chemical composition and economic evaluation	2012	[44]
		Extraction of omega-3 fatty acids and astaxanthin from Brazilian redspotted shrimp waste using supercritical CO ₂ + ethanol mixtures	2012	[45]
		Modeling oil extraction from green and roasted coffee by means of supercritical CO ₂	2012	[46]
		Supercritical extraction of neolignans from <i>Piper regnelli</i> var. <i>pallescens</i>	2012	[47]
		Supercritical extraction of phloroglucinol and benzophenone derivatives from <i>Hypericum carinatum</i> : Quantification and mathematical modeling	2011	[48]
		Supercritical fluid extraction of volatile and non-volatile compounds from <i>Schinus molle</i> L	2011	[49]
		Antifungal activity of supercritical fluid extract obtained from <i>Calophyllum brasiliense</i> Cambess	2011	[50]
		Identification of organic sulfur compounds in coal bitumen obtained by different extraction techniques using comprehensive two-dimensional gas chromatography coupled to time-of-flight mass spectrometric detection	2011	[51]
		Supercritical fluid extracts from the Brazilian cherry (<i>Eugenia uniflora</i> L.): Relationship between the extracted compounds and the characteristic flavour intensity of the fruit	2011	[52]
		Pink shrimp (<i>P. brasiliensis</i> and <i>P. paulensis</i>) residue: Influence of extraction method on carotenoid concentration	2011	[53]
		Extraction of sunflower (<i>Heliantus annuus</i> L.) oil with supercritical CO ₂ and subcritical propane: Experimental and modeling	2011	[54]
		Acute toxicity and anti inflammatory effects of supercritical extracts of <i>Ilex paraguariensis</i>	2011	[55]
		Extraction of canola seed (<i>Brassica napus</i>) oil using compressed propane and supercritical carbon dioxide	2011	[56]
		Scale-up study of supercritical fluid extraction process for clove and sugarcane residue	2011	[57]
Chamomile extraction with supercritical carbon dioxide: Mathematical modeling and optimization	2011	[58]		
Supercritical CO ₂ extraction of lipids and astaxanthin from Brazilian redspotted shrimp waste (<i>Farfantepenaeus paulensis</i>)	2011	[59]		
Proximate composition and extraction of carotenoids and lipids from Brazilian redspotted shrimp waste (<i>Farfantepenaeus paulensis</i>)	2011	[60]		

Table 1. Continued

BRAZIL	Extraction	Extraction with supercritical fluid and comparison of chemical composition from adults and young leaves of <i>Zanthoxylum tingoassuiba</i>	2011	[61]
		Bioactive extracts of orange (<i>Citrus sinensis</i> L. Osbeck) pomace obtained by SFE and low pressure techniques: Mathematical modeling and extract composition	2010	[62]
		Supercritical fluid extraction and high performance liquid chromatographic determination of benzopyrans and phloroglucinol derivative in <i>Hypericum polyanthemum</i>	2010	[63]
		Supercritical fluid extraction of alkaloids from <i>Ilex paraguariensis</i> St. Hil	2010	[64]
		Extraction of sesame seed (<i>Sesamun indicum</i> L.) oil using compressed propane and supercritical carbon dioxide	2010	[65]
		Supercritical fluid extraction of lycopene from tomato juice and characterization of its antioxidation activity	2010	[66]
		Recovery of gamma-oryzanol from rice bran oil byproduct using supercritical fluid extraction	2010	[67]
		Supercritical fluid extraction of peach (<i>Prunus persica</i>) almond oil: Process yield and extract composition	2010	[68]
		A study of the methods of carotenoid extraction in carrots using supercritical fluid extraction (SFE) and conventional methods	2010	[69]
		Supercritical fluid extraction from dried banana peel (<i>Musa spp.</i> , genomic group AAB): Extraction yield, mathematical modeling, economical analysis and phase equilibria	2010	[70]
Fundamental & thermodynamic studies	Fundamental & thermodynamic studies	Characterization and functional properties of macela (<i>Achyrocline satureioides</i>) extracts obtained by supercritical fluid extraction using mixtures of CO ₂ plus ethanol	2010	[71]
		Extraction of the essential oil of abajeru (<i>Chrysobalanus icaco</i>) using supercritical CO ₂	2010	[71]
		Thermodynamic study of enantioseparation of mitotane by supercritical fluid chromatography	2012	[72]
		High-pressure phase behaviour of the system (CO ₂ + CI Disperse Orange 30 dye)	2012	[73]
		Selectivity of supercritical carbon dioxide in the fractionation of fish oil with a lower content of EPA plus DHA	2012	[74]
		Safety study of an experimental apparatus for extraction with supercritical CO ₂	2012	[75]
		Phase equilibrium data for the ternary system (propane plus chloroform plus oryzanol)	2011	[76]
		Supercritical technology as an alternative for biotechnological xylitol purification	2011	[77]
		Phase behavior of (CO ₂ + methanol plus lauric acid) system	2011	[78]
		High-pressure experimental data of CO ₂ + mitotane and CO ₂ + ethanol plus mitotane mixtures	2011	[79]

Table 1. Continued

Fundamental & thermodynamic studies	Thermodynamic modeling of liquid-fluid phase equilibrium in supercritical ethylene plus copolymer plus co-solvent systems using the PC-SAFT equation of state	2010	[80]	
	Phase behaviour of binary systems of lactones in carbon dioxide	2010	[81]	
	Phase behaviour of the ternary system poly(epsilon-caprolactone) plus carbon dioxide plus dichloromethane	2010	[82]	
	Phase equilibrium data and thermodynamic modeling of the system propane plus NMP plus methanol at high pressures	2010	[83]	
	Phase equilibrium measurements and modelling of ternary system (carbon dioxide plus ethanol plus palmitic acid)	2010	[84]	
	Chemical characterization and phase behaviour of grape seed oil in compressed carbon dioxide and ethanol as co-solvent	2010	[85]	
	High-pressure phase diagram of the drug mitotane in compressed and/or supercritical CO ₂	2010	[86]	
	A first-principles simulation model for the thermo-hydraulic performance of fan supplied tube-fin heat exchangers	2010	[87]	
BRAZIL	Materials and micronization	Development of gas sensors coatings by polyaniline using pressurized fluid	2012	[88]
		Purification of single-wall carbon nanotubes by heat treatment and supercritical extraction	2011	[89]
		CO ₂ geological storage in saline aquifers: Parana basin caprock and reservoir chemical reactivity	2011	[90]
		Synthesis and characterization of ZnO/PET composite using supercritical carbon dioxide impregnation technology	2011	[91]
		Economical viability of SFE from peach almond, spearmint and marigold	2011	[92]
		In vitro release profiles of beta-carotene encapsulated in PHBV by means of supercritical carbon dioxide micronization technique	2011	[93]
		Impregnation of composite from polycarbonate (PC) and silica gel (Si) films with photochromic dye in supercritical fluid	2010	[94]
		Precipitation and encapsulation of beta-carotene in PHBV using carbon dioxide as anti-solvent	2010	[95]
		Gas sensors development using supercritical fluid technology to detect the ripeness of bananas	2010	[96]
		Petroleum applications	Mesophase evolution in heat-treated solid petroleum pitches	2012
Comparison of residual oil saturation for water and supercritical CO ₂ flooding in a long core, with live oil at reservoir conditions	2011		[98]	
Methods for the determination of conjugated dienes in petroleum products: a review	2010		[99]	
Reactions in supercritical fluids	Biocomposites based on cellulose acetate and short curaua fibers treated with supercritical CO ₂	2012	[100]	
	Enzymatic synthesis of galactooligosaccharides using pressurised fluids as reaction medium	2012	[101]	

Table 1. Continued

BRAZIL	Reactions in supercritical fluids	Assessment of carotenoids recovery through cell rupture of <i>Sporidiobolus salmonicolor</i> CBS 2636 using compressed fluids	2012	[102]
		Effect of compressed fluids treatment on the activity of inulinase from <i>Kluyveromyces marxianus</i> NRRL Y-7571 immobilized in montmorillonite	2011	[103]
		Effect of compressed fluids treatment on the activity, stability and enzymatic reaction performance of beta-galactosidase	2011	[104]
		Optimization of laccase catalyzed degradation of reactive textile dyes in supercritical carbon dioxide medium by response surface methodology	2010	[105]
		Compressed propane as a new and fast method of pre-purification of radish (<i>Raphanus sativus</i> L.) peroxidase	2010	[106]
		Effect of treatment with compressed propane on lipases hydrolytic activity	2010	[107]
		Branched polyethylenes fractionated in supercritical propane	2010	[108]
		Lipase from <i>Rhizomucor miehei</i> as a biocatalyst in fats and oils modification	2010	[109]
	Lipase from <i>Rhizomucor miehei</i> as an industrial biocatalyst in chemical process	2010	[110]	
	Review and perspectives	Technological aspects of beta-carotene production	2011	[111]
Occurrence and chemical speciation analysis of organotin compounds in the environment: A review		2010	[112]	
Supercritical fluid extraction of bioactive compounds: Fundamentals, applications and economic perspectives		2010	[113]	
CHILE	Analytical applications	A protocol for evaluating the safety of herbal preparations in a rat model: the case of a supercritical fluid extract of Saw Palmetto	2010	[114]
	Extraction	A polyphenol extract of tara pods (<i>Caesalpinia spinosa</i>) as a potential antioxidant in oils	2012	[115]
		Extraction of oil and minor lipids from cold-press rapeseed cake with supercritical CO ₂	2012	[116]
		Effect of boldo (<i>Peumus boldus</i> M.) pretreatment on kinetics of supercritical CO ₂ extraction of essential oil	2012	[117]
		Mass transfer and equilibrium parameters on high-pressure CO ₂ extraction of plant essential oils	2011	[118]
		Oxidative stability of oils containing olive leaf extracts obtained by pressure, supercritical and solvent-extraction	2011	[119]
		Extraction of antioxidants from several berries pressing wastes using conventional and supercritical solvents	2010	[120]
	Fundamental & thermodynamic studies	A refined equation for predicting the solubility of vegetable oils in high-pressure CO ₂	2012	[121]
		Free solute content and solute-matrix interactions affect apparent solubility and apparent solute content in supercritical CO ₂ extractions. a hypothesis paper	2012	[122]
		Supercritical CO ₂ extraction of allicin from garlic flakes: Screening and kinetic studies	2012	[123]

Table 1. Continued

CHILE		Molar isopycnicity in heterogeneous binary mixtures	2012	[124]	
		Optimization of a cubic equation of state and van der Waals mixing rules for modeling the phase behavior of complex mixtures	2012	[125]	
		Stevia rebaudiana Bertoni, source of a high-potency natural sweetener: A comprehensive review on the biochemical, nutritional and functional aspects	2012	[126]	
	Fundamental & thermodynamic studies		Solubility of beta-carotene in ethanol- and triolein-modified CO ₂	2011	[127]
			Simulation of a supercritical carbon dioxide extraction plant with three extraction vessels	2011	[128]
			Solubility of nutraceutical carotenoid compounds in pure supercritical CO ₂ and modified with triolein or ethanol	2010	[129]
			Solubilities in supercritical carbon dioxide of (2E,6E)-3,7,11-Trimethyldodeca-2,6,10-trien-1-ol (Farnesol) and (2S)-5,7-Dihydroxy-2-(4-hydroxyphenyl)chroman-4-one (Naringenin)	2010	[130]
	Data analysis, modeling and thermodynamic consistency of CO ₂ + beta-carotene high pressure mixtures	2010	[131]		
	Reactions in supercritical fluids	Recent trends in biocatalysis engineering	2012	[132]	
COLOMBIA	Extraction	Extraction of phenolic fraction from guava seeds (<i>Psidium guajava</i> L.) using supercritical carbon dioxide and co-solvents	2010	[133]	
		Extraction of pesticides from soil using supercritical carbon dioxide added with methanol as co-solvent	2012	[134]	
		Design and analysis of antioxidant compounds from Andes Berry fruits (<i>Rubus glaucus</i> Benth) using an enhanced-fluidity liquid extraction process with CO ₂ and ethanol	2012	[135]	
		Extraction of oil from chia seeds with supercritical CO ₂	2011	[136]	
		Guava (<i>Psidium guajava</i> L.) seed oil obtained with a homemade supercritical fluid extraction system using supercritical CO ₂ and co-solvent	2011	[137]	
		<i>Lippia origanoides</i> chemotype differentiation based on essential oil GC-MS and principal component analysis	2011	[138]	
		Integrated utilization of guava (<i>Psidium guajava</i> L.): antioxidant activity of phenolic extracts obtained from guava seeds with supercritical CO ₂ -ethanol	2011	[139]	
		Extraction of phenolic fraction from guava seeds (<i>Psidium guajava</i> L.) using supercritical carbon dioxide and co-solvents	2010	[140]	
		Separation of fractions from vacuum residue by supercritical extraction	2010	[141]	
		Reacting flow simulations of supercritical water oxidation of PCB-contaminated transformer oil in a pilot plant reactor	2011	[142]	
			Reactions in supercritical fluids	Biodiesel fuels through a continuous flow process of chicken fat supercritical transesterification	2010
		On the centre of mass velocity in molecular dynamics simulations	2012	[144]	

Table 1. Continued

MEXICO		Effect of a temperature gradient on ellipsometry measurements in supercritical CO ₂	2012	[145]	
		Correlation and prediction of fluid-fluid equilibria of carbon dioxide-aromatics and carbon dioxide-dichlorobenzoates binary mixtures	2011	[146]	
	Fundamental & thermodynamic studies		Solubility of mesquite gum in supercritical carbon dioxide	2011	[147]
			New apparatus for solubility measurements of solids in carbon dioxide	2011	[148]
			Loci of extrema of thermodynamic response functions for the Lennard-Jones fluid	2011	[149]
			Solubility and density measurements of palmitic acid in supercritical carbon dioxide plus alcohol mixtures	2010	[150]
	Materials and micronization		Microencapsulation of Coenzyme Q(10) in Poly(ethylene glycol) and Poly(lactic acid) with Supercritical Carbon Dioxide	2012	[151]
			Hydrothermal synthesis of monodisperse single-crystalline alpha-quartz nanospheres	2011	[152]
	Petroleum applications		Removal of polycyclic aromatic hydrocarbons from soil: A comparison between bioremoval and supercritical fluids extraction	2012	[153]
			Remediation of soils contaminated with total petroleum hydrocarbons and polycyclic aromatic hydrocarbons: extraction with supercritical ethane	2010	[154]
Reactions in supercritical fluids		Lipase-catalyzed syntheses of linear and hyperbranched polyesters using compressed fluids as solvent media	2010	[155]	
Fundamental & thermodynamic studies		Stability of ethyl esters from soybean oil exposed to high temperatures in supercritical ethanol	2011	[156]	
URUGUAY	Review and perspectives	Analytical methods for pesticide residues in rice	2011	[157]	

2. Summary of the scientific investigations

Figure 1 presents a description of supercritical technology scenario in Latin America. The studies developed in the past 3 years represent 30% of the total studies done in Latin America along the time. Some research teams, mainly in Argentina, Brazil, Chile, Colombia and Mexico, are recently focusing in promising sub-areas, such as: the analysis of target compounds by supercritical fluid chromatography, use of supercritical fluids to hydrolyze biomass for sugar production that can be utilized for second generation ethanol production, application of compressed fluids in bioprocess area for evaluating the enzymes stability, for instance, and the formation of micro and nano particles of functional pigments using supercritical CO₂.

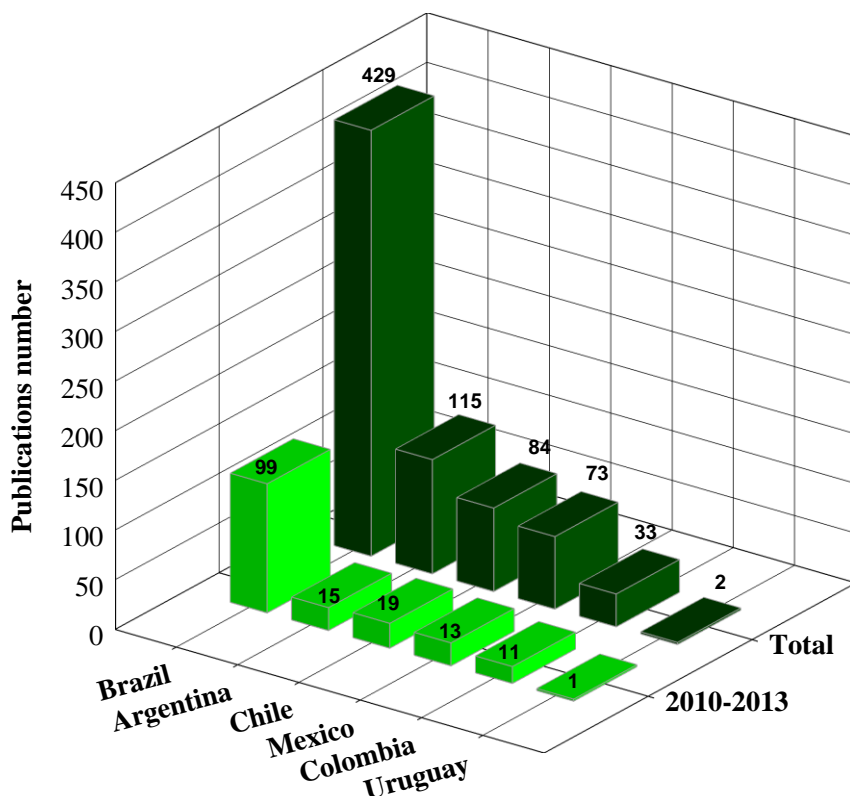


Figure 1. Overview of scientific papers dealing with supercritical fluids performed in Latin America.

3. Patents survey

A search of patents inserting the term 'supercritical fluid*' in Derwent Innovations Index, at ISI Web of Knowledge data basis, returned a content of 5,632 patents. However, only 2 patents were found addressed in one of the 33 countries belonging to Latin America. Indeed, the patents are registered in local data basis, as is the case of Brazil where the patents are deposited at INPI (Brazilian National Institute of Industrial Property). The 2 patents found at ISI Web of Knowledge data basis were invented in Colombia. The invention WO2012066389 [158] is a novel process for the production of aqueous suspensions of micro and nanoparticles of calcium salts smaller than 10 μm using critical, subcritical and supercritical carbon dioxide. This property of the fluid increases the solubility of the calcium salt, which allows enriching nutritional, nutraceutical and pharmaceutical beverages with calcium salts. The invention US2011237857 [159] is a process for the destruction of toxic residues via oxidation in the presence of water and oxygen developed in homogeneous supercritical condition of 647 K and 22 MPa. The mobile unit proposed of processing is composed of a reactor, which includes pressurization, reaction, cooling, depressurization and sampling zones for the destruction of toxic residues like polychloride biphenyls and pyridines.

4. Concluding remarks

The new applications of supercritical fluids represent a favorable condition for including a technological plant in Latin America to process high-added value materials. The research and development of know-how activities performed in universities and research centers by the Latin-American scientists in the past years contribute to the implementation of supercritical technology in industry scale. The large biodiversity of raw materials found in the referred countries is a key-factor for becoming these future trends properly applicable.

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