Role of extracts obtained from rainbow trout side streams by accelerated solvent extraction and pulsed electric fields on modulating bacterial and anti-inflammatory activities

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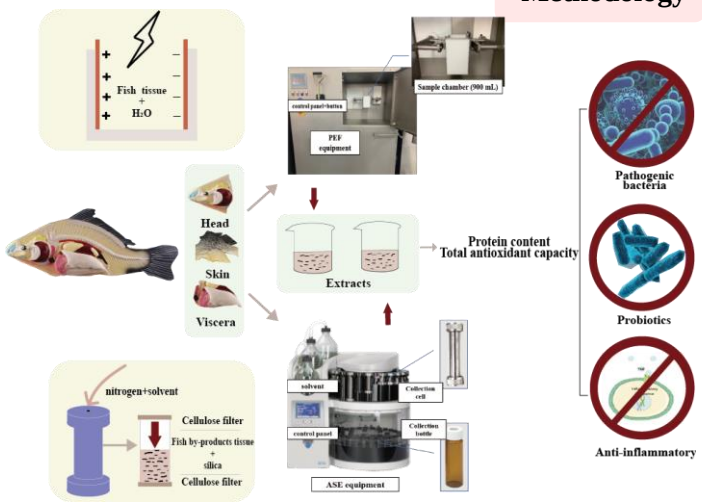
Introduction

In this study, accelerated solvent extraction (ASE) and pulsed electric field (PEF) were used as innovative approaches to recover extracts from rainbow trout side streams rich in high-added-value compounds. Then, the impact of the obtained extracts on bacterial growth and anti-inflammatory potential was evaluated. Moreover, the protein content and the total antioxidant capacity of the samples were determined. The results showed that some extracts could inhibit the growth of pathogenic bacteria, such as the ASE rainbow trout skin, which showed a significant antibacterial activity on *Staphylococcus aureus*. In addition, some extracts promoted probiotic bacteria growth. For example, the PEF rainbow trout head and skin extracts promoted *Lactobacillus casei* growth. Furthermore, some samples, such as ASE rainbow trout viscera had interesting anti-inflammatory properties. Therefore, the use of ASE and PEF can be considered as useful strategies to recover antimicrobial, prebiotic, and anti-inflammatory extracts from rainbow trout and sole side streams although it is necessary to evaluate one by one each specific side stream.

Methodology



Results

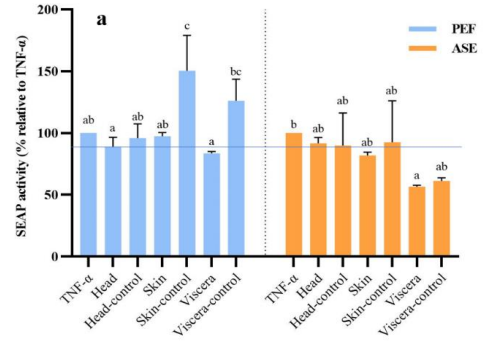
Protein/TAC

Methods	Sample	Protein content (mg/mL)	ORAC (μM TE)	TEAC (μM TE)
ASE	Head	2.63±0.01^{g}	1919.842±267.23^{b}	1070.48±21.09^{e}
	Head-control	0.91±0.01^{c}	594.886±59.00^{a}	328.71±6.42^{a}
	Skin	5.56±0.14^{i}	6044.177±597.70^{e}	1153.21±1.79^{f}
	Skin-control	3.79±0.07^{h}	2895.714±296.71^{c}	438.00±25.71^{b}
	Viscera	1.83±0.10^{f}	7823.500±836.86^{f}	1933.71±28.57^{h}
	Viscera-control	1.51±0.07^{e}	6295.981±508.82^{e}	1341.03±32.14^{g}
PEF	Head	0.68±0.01^{a}	2055.449±130.05^{d}	339.43±6.43^{a}
	Head-control	0.78±0.01^{b}	1069.146±170.97^{bc}	496.93±20.36^{b}
	Skin	1.75±0.03^{f}	1295.166±208.77^{c}	625.43±52.86^{c}
	Skin-control	1.84±0.01^{f}	1051.422±49.55^{bc}	626.86±31.43^{c}
	Viscera	1.11±0.02^{d}	5542.176±574.59^{g}	1321.71±42.86^{g}
	Viscera-control	1.05±0.01^{d}	3027.315±267.09^{f}	1011.05±77.14^{d}

Microbial

Sample	PEF		ASE		PEF		ASE	
	Growth rate (μmax, h^{-1})	MOD *	Growth rate (μmax, h^{-1})	MOD*	**Growth rate (μmax, h^{-1})**	MOD *	Growth rate (μmax, h^{-1})	MOD*
	Lactobacillus casei				***S. aureus***			
Bacteria-control	0.349±0.008^{ab}	3.597±0.011^{ab}	0.360±0.012^{c}	1.524±0.015^{a}	0.591±0.039^{ab}	2.216±0.215^{a}	0.524±0.056^{cd}	2.401±0.047^{a}
Head	0.382±0.011^{cd}	3.681±0.038^{bc}	0.349±0.007^{bc}	1.603±0.008^{bc}	0.560±0.054^{ab}	2.309±0.142^{a}	0.441±0.041^{ab}	2.559±0.018^{ab}
Head-control	0.374±0.004^{cd}	3.836±0.053^{c}	0.337±0.009^{b}	1.554±0.041^{ab}	0.559±0.003^{ab}	2.309±0.124^{a}	0.448±0.026^{b}	2.455±0.053^{a}
Skin	0.369±0.002b^{cd}	3.719±0.062^{bc}	0.334±0.007^{b}	1.503±0.037^{a}	0.505±0.043^{ab}	2.545±0.126^{ab}	0.404±0.008^{a}	2.796±0.034^{c}
Skin-control	0.390±0.017^{d}	3.683±0.069^{b}	0.288±0.011^{a}	1.512±0.016^{a}	0.496±0.036^{ab}	2.533±0.135^{ab}	0.482±0.003^{bc}	2.492±0.048^{a}
Viscera	0.360±0.000^{abc}	3.533±0.036^{a}	0.283±0.006^{a}	1.613±0.015^{c}	0.550±0.026^{ab}	2.751±0.067^{b}	0.579±0.037^{e}	2.724±0.034^{bc}
Viscera-control	0.336±0.012^{a}	3.595±0.071^{ab}	0.271±0.005^{a}	1.616±0.005^{cd}	0.596±0.041^{b}	2.579±0.077^{ab}	0.578±0.049^{e}	2.642±0.053^{bc}
	Bifidobacterium lactis				***Salmonella***			
Bacteria-control	0.536±0.027	3.597±0.011^{c}	0.536±0.027^{ab}	2.346±0.009^{abc}	0.335±0.026^{a}	1.838±0.065	0.335±0.026^{a}	1.838±0.065
Head	0.542±0.035	3.681±0.006^{c}	0.557±0.019^{b}	2.274±0.039^{ab}	0.353±0.030^{ab}	1.831±0.164	0.308±0.002^{a}	1.714±0.151
Head-control	0.544±0.027	3.836±0.006^{b}	0.536±0.024^{ab}	2.256±0.029^{ab}	0.361±0.025^{ab}	1.756±0.151	0.308±0.005^{a}	1.655±0.055
Skin	0.508±0.028	3.719±0.000^{b}	0.547±0.014^{b}	2.202±0.106^{ab}	0.323±0.007^{a}	1.859±0.043	0.315±0.024^{a}	1.766±0.157
Skin-control	0.561±0.014	3.683±0.010^{b}	0.498±0.008^{ab}	2.159±0.059^{a}	0.346±0.022^{ab}	1.810±0.171	0.302±0.025^{a}	1.798±0.049
Viscera	0.550±0.021	3.533±0.007^{a}	0.529±0.010^{ab}	2.299±0.003^{abc}	0.308±0.021^{a}	1.863±0.214	0.418±0.021^{b}	1.687±0.049
Viscera-control	0.532±0.023	3.595±0.009^{a}	0.530±0.007^{ab}	2.243±0.022^{ab}	0.390±0.005^{b}	1.678±0.132	0.447±0.031^{b}	1.675±0.004

Anti-inflammatory



Results

From the results obtained in this study it can be concluded that PEF and ASE can be used as useful alternative approaches to recovering extracts with antimicrobial, prebiotic, and anti-inflammatory properties. In addition, some extracts showed anti-bacterial and anti-inflammatory effects. When PEF was studied, PEF rainbow trout head and skin extracts also showed an inhibitory effect on the growth of *S. aureus*. In addition, they also promoted the growth of *Lactobacillus casei*. It was also found that some extracts showed anti-inflammatory potential, such as those obtained from ASE and non-ASE rainbow trout viscera. In general, these extracts can be considered as potentially valuable functional substances for further study their beneficial effects on humans.