



# Sensory characterisation and physical properties of abalone, *Haliotis tuberculata coccinea* reared under different conditions

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# Introduction

- Abalone have high content of collagen and myofibrillar proteins, important in determining the textural properties of abalone meat (Zhu et al., 2011) and its eating quality perceived by consumers that tend to prefer tender abalone (Gao, Tashiro, & Ogawa, 2002).
- The eating quality of abalones is determined by characteristics such as texture, aroma, appearance, and size (Olley, & Thrower, 1977; Oakes, & Ponte, 1996), among them the textural properties, are the most critical factors.

The present study, aims at identifying quality differences of commercial size, farmed *Haliotis tuberculata*, subject to different production and feeding systems.



- Characterize the abalone sensory and physical properties reared under different conditions.
- Designate a cooking method adapted to the product attributes and its acceptance.
- Evaluate the TPA (Texture Profile Analysis), sensory profile and color in relation to the diet and the rearing systems.

-Recirculating Aquaculture System (RAS)  
-Flow Through System (FLOW)

Feed Algae (FA), Commercial Feed (CF) and a mixture of Algae and Commercial Feed (MIX).

# Materials and methods

## Experimental Design



6 months  
Abalone



RAS



FLOW



FA



CF



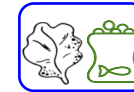
MIX



FA



CF



MIX



ABFEED®

Source:  
Marifeed

# Materials and methods

## Texture Analyses

### Texture Profile Analysis (TPA)

7 texture parameters

Force-deformation curve

Hardness

Springiness

Cohesiveness

Chewiness

Gumminess

Adhesiveness

Resilience



TA-XT2 Texture Analyzer

Compression plate and speed were set to two consecutive cycles to a depth of 60% of deformation, to a constant speed of 6mm/s and 5s between cycles

(Ginés *et al.*, 2004).

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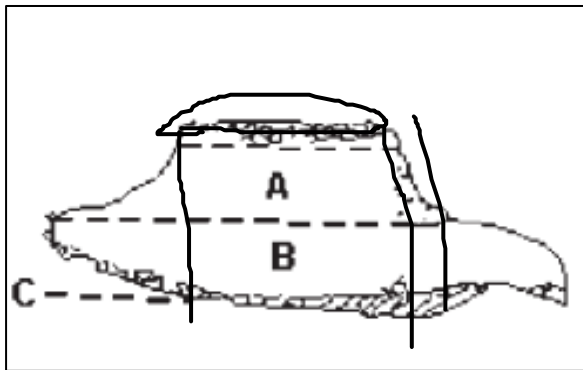
Steamed for 2 min to preserve flavor, nutritional characteristics, aromas, texture and consistency (Nieto, 2014).



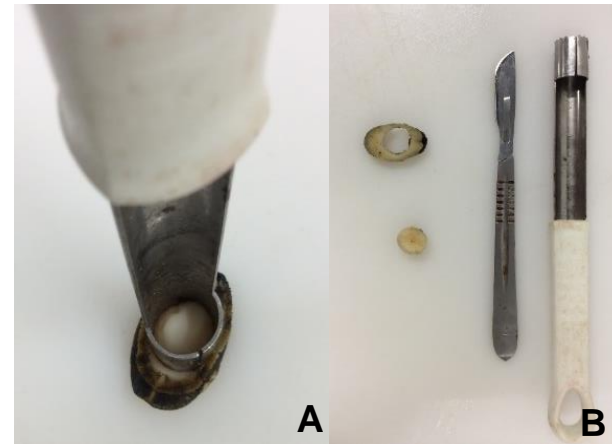
# Materials and methods

## Texture Analyses

Cylindrical pieces about 1.2 cm of diameter and around 1 cm height. (Dong *et al.*, 2017)



Lateral view of the abalone. A. Adductor muscle  
B. Foot muscle C. Epipodium (Sanchez *et al.*, 2006)

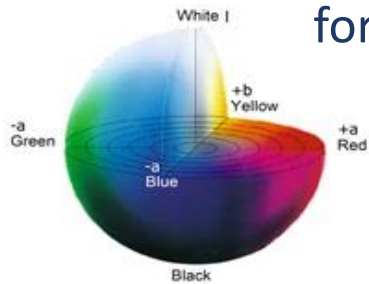


A. Cutting the abalones foot with the Apple Corer.  
B. Cylindrical piece obtained.

# Materials and methods

## Colour Analyses

Lightness ( $L^*=0$  for black,  $L^*=100$  for white)



Color space defined by the International Commission on Illumination (CIE) in 1976. CIELAB  
source: coat industries

**a** intensity in red

**b** intensity in yellow

Chroma [ $\sqrt{(a^2 + b^2)}$ ]: purity, intensity, of a color. + = brighter, - = duller

**Hue** [ $\arctan(b/a)$ ]: distinction between colors positioned around a color wheel (Cleyton, 2017).



Colorimeter CR-400.

Sensory Evaluation



9

members





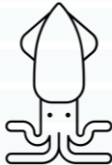

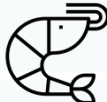


Panel training



# Materials and methods

## Sensory Evaluation

### Attributes Selected for the Abalone Sensory Evaluation

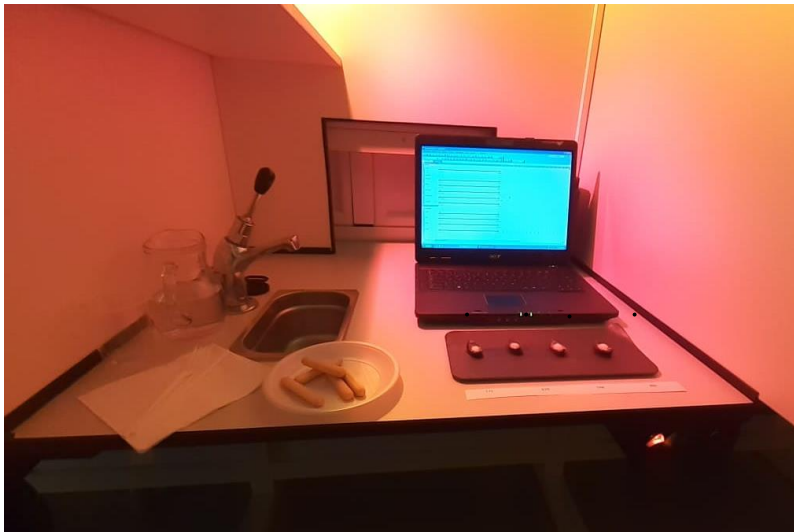
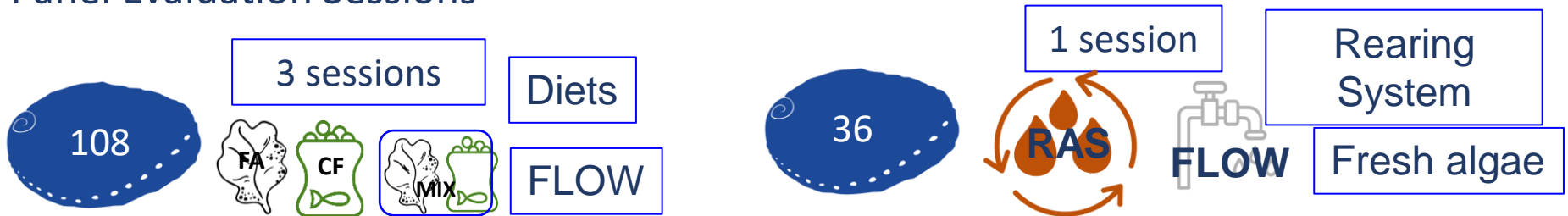
Attributes	Description
<b>Odour</b>	
Seafood	Odour related with seafood 
	Algae
<b>Texture</b>	
Springiness	Degree to which a sample returns to its original shape after partial compression with the molar teeth
Hardness	Force to compress the sample one bite with molar teeth
Gumminess	Force required to separate the muscle mioners
Chewiness	Amount of chewing requiered before swallowing
Juiciness	Amount of liquid released when the sample is chewed
	   <b>2 min.</b>
<b>Flavour</b>	Solutions
Seafood	Flavour related with seafood 
Sweet	Degree of taste slightly sweet
Umami	Taste of the salt of glutamic acid. Recognized as one of the basic tastes
Bitter	Flavour like Caffeine
	  Mono sodium glutamate

# Materials and methods

Sensory Evaluation



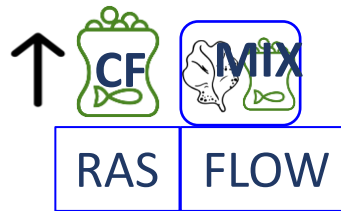
Panel Evaluation Sessions



## Edible percentage and After Cooking Weight Lost

Diet x rearing systems

Significant effect ( $p < 0.05$ ) After Cooking Weight Lost



**protein composition** of the muscle. The fresh algae fed abalone, whose protein content was the highest presented the lowest weight loss.

Rearing system

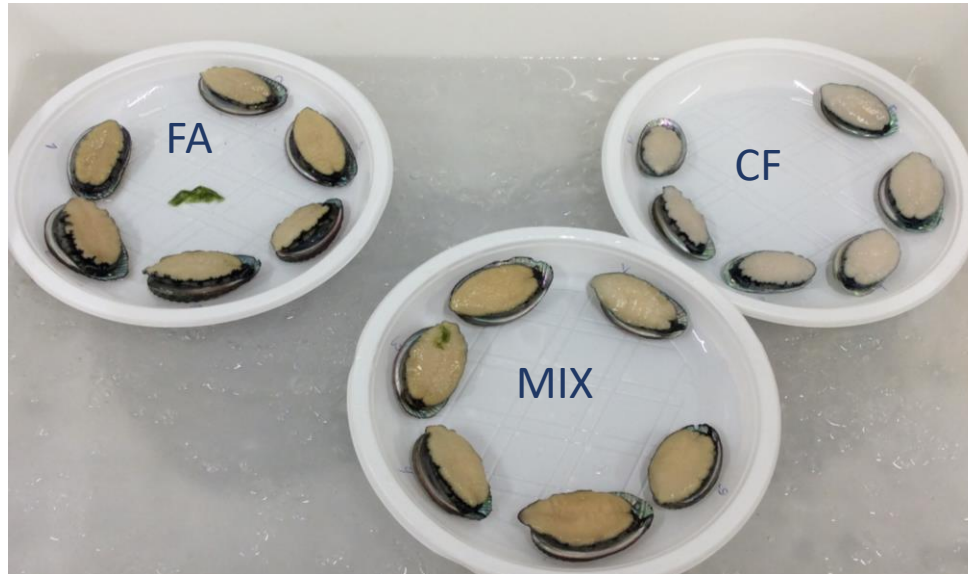
Significant effect ( $p < 0.05$ ) Edible percentage



## Colour

Diet

( $p < 0.05$ )



Allen *et al.* (2006)  
New Zealand  
Blackfoot abalone,  
darker ingesting algae  
(Hoang *et al.*, 2016)  
*Haliotis laevigata* fed  
fresh *Ulva* or  
fresh *Gracilaria*  
*cliftonii* produced  
**yellowish foot**

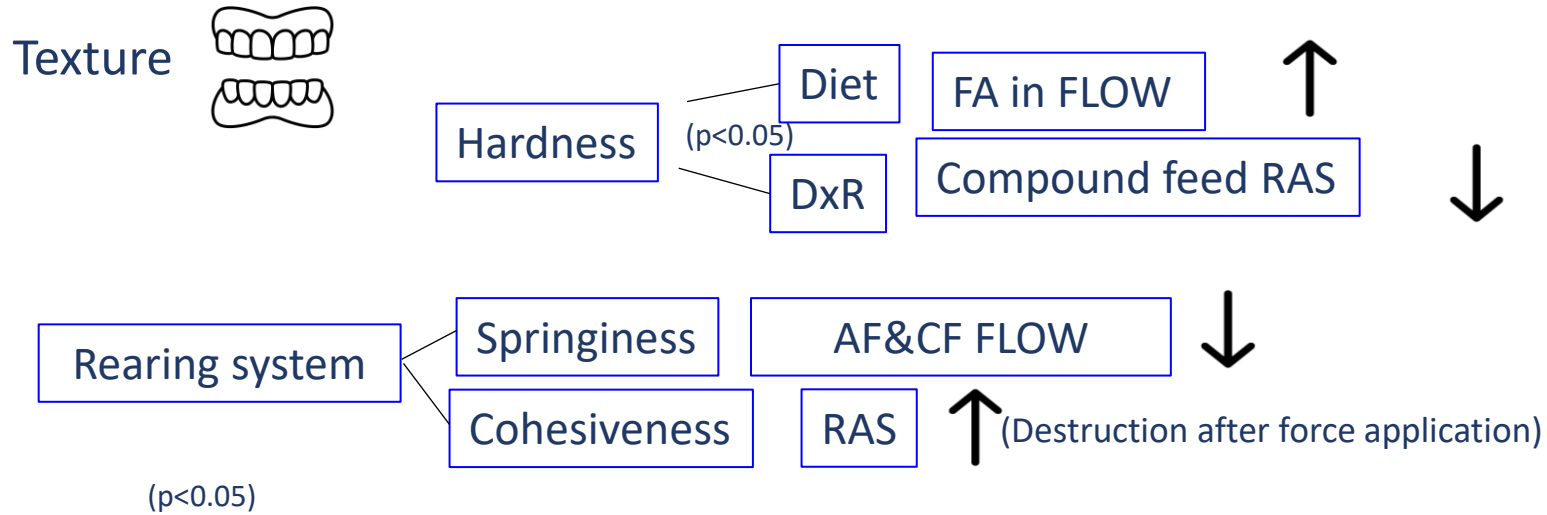
-Compound Feed RAS FLOW  
whiter

- FA and Mix fed abalone  
reared in FLOW and RAS  
more yellow

-Chroma and Hue,  
compound Feed

No differences in color between  
between raw and cooked product as  
reported by He *et al.* (2019)

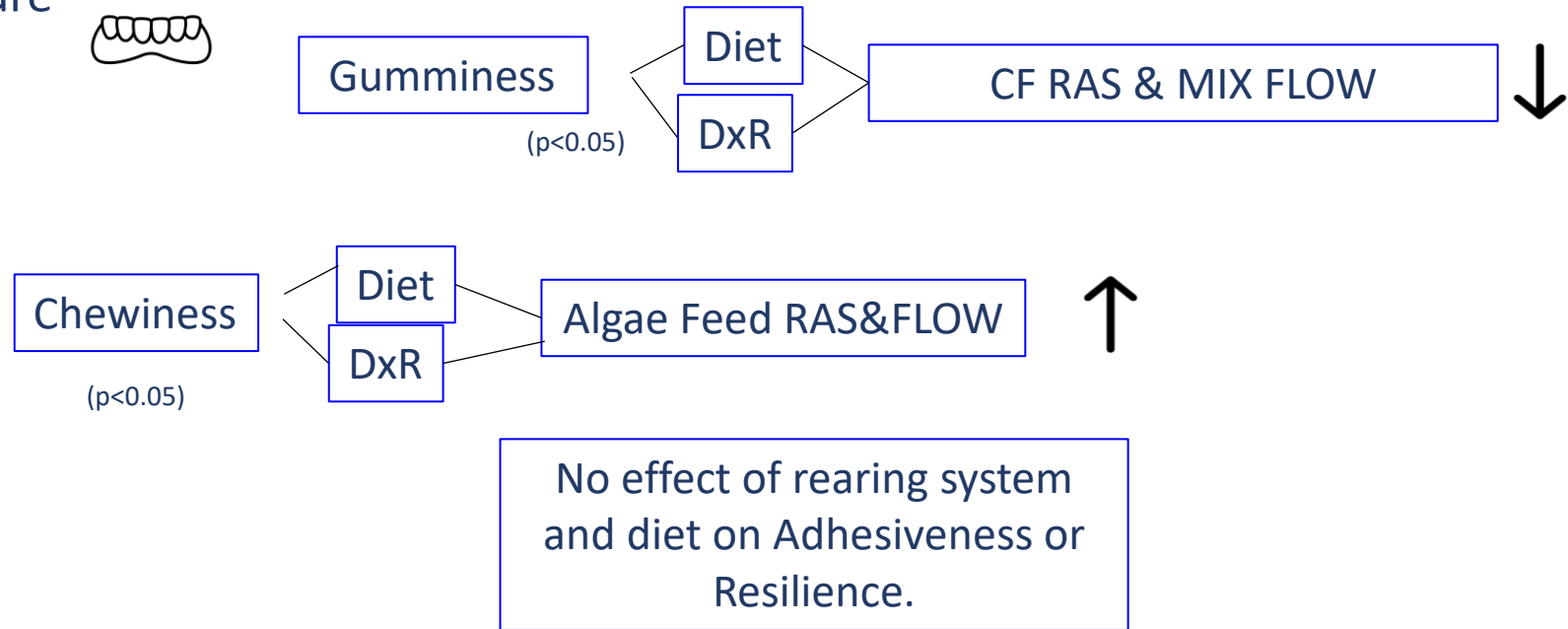
# Results & discussion



Diets and production environment could impact diameter and width of muscle fibers, and the distances between them (Brown *et al.* 2008; Gao *et al.*, 2002; Kihlman *et al.*, 2013) can explain differences observed in **Textural properties**.

# Results & discussion

Texture



Difference in **gumminess** and **chewiness** could be related with the **collagen content** influenced by the diet and the production environment (Chandra *et al.*, 2014).

# Results & discussion

## Sensory Evaluation

	Flow Through System		
Atributes	Algae Feed	Compound Feed	Mix
<b>Odour</b>			
Seafood	69.83±13.36 <sup>a</sup>	56.61±10.88 <sup>b</sup>	72.22±15.15 <sup>a</sup>
<b>Texture</b>			
Springiness	71.11±11.78 <sup>a</sup>	57.61±13.03 <sup>b</sup>	73.61±10.99 <sup>a</sup>
Hardness	69.61±13.44 <sup>a</sup>	55.94±14.50 <sup>b</sup>	72.39±12.50 <sup>a</sup>
Gumminess	68.78±13.47 <sup>a</sup>	56.06±13.94 <sup>b</sup>	71.06±11.52 <sup>a</sup>
Chewiness	72.61±10.36 <sup>a</sup>	62.08±12.55 <sup>b</sup>	76.22±8.66 <sup>a</sup>
Juiciness	70.39±9.57	69.97±9.28	71.83±7.18
<b>Flavour</b>			
Seafood	68.44±11.06 <sup>a</sup>	57.17±8.66 <sup>b</sup>	70.50±8.40 <sup>a</sup>
Sweet	65.50±11.04 <sup>a</sup>	60.72±11.22 <sup>b</sup>	64.67±9.81 <sup>a</sup>
Umami	65.11±12.01	66.33±11.49	65.11±11.55
Bitter	49.33±27.58 <sup>b</sup>	58.28±21.09 <sup>a</sup>	47.00±24.21 <sup>b</sup>

Values expressed in mean ± SD. Different letters within a line indicate significant differences among dietary treatments ( $P < 0.05$ )

# Results & discussion

According to market expectations in terms of seafood odour and flavour abalone fed **MIX** and **AF** had **highest scores** similarly Tasmanian abalone fed fresh algae was perceived as **higher in sweetness** (Cochet *et al.*,2013) due to high glycine and glutamate content. **On the contrary** animals fed **CF** were perceived as the most **bitter**.

In terms of texture abalone fed **CF** presented lowest scores for all the parameters, meaning that **less force** and **less chewing** is needed to compress the product between molars representing good market characteristics.

Panel session comparing animals fed fresh algae in the different rearing systems gave **highest score** for all texture parameters **in RAS** and more intense seafood and sweet flavours were also found **but no significant differences** were found between the systems.

# Conclusions

- Steaming for 2 minutes was judged as adequate to perform abalone sensory analysis.
- Descriptive sensory analysis can measure differences in sensory properties among abalone varying in their rearing conditions.
- Diet and rearing systems seem to have a high impact on sensory properties of abalone.
- Diet has a significant effect on the foot color.
- Abalone fed **MIX** and **FA** diets present **highest scores** seafood odour and flavour
- Abalone fed **CF** presented better texture parameters Fresh Algae fed abalone presented more hardness, gumminess, and chewiness than abalones fed compound feed.
- No significant differences were found between rearing systems for animals fed FA



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