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Effect of information on Chinese consumers' acceptance of thermal and non-thermal treated apple juices: A study of young Chinese immigrants in New Zealand

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ABSTRACT

This study examined the effects of technology information on Chinese consumers' acceptance of thermal and non-thermal treated apple juices. Apple juice was treated using thermal, high hydrostatic pressure processing and pulsed-electric field processing methods and compared to untreated apple juice. The four juices were evaluated by 118 Chinese consumers in three testing conditions: (a) blind (rating acceptance of the apple juices without any information), (b) label (rating acceptance of the apple juice labels containing different technology information without tasting the juices), and (c) informed (rating acceptance of the apple juices by tasting the juices and observing the labels containing different technology information). Results showed that technology information had the strongest positive influence on consumers' acceptance for untreated and high hydrostatic pressure processed apple juices. No effect of technology information on the acceptance of pulsed-electric field treated apple juice was observed. Acceptance was lower for thermal treated apple juice, but its sensory characteristics were good enough to minimize the negative effect of technology information on acceptability. The findings of this study help manufacturers understand how technology information affect Chinese consumers' acceptance of apple juices. When marketing non-thermal processed beverages, especially high hydrostatic pressure processed ones, to young and educated Chinese consumers, food manufacturers are recommended to focus on technology information as a selling point as this information strongly influences expectations and acceptance of the product. However, it should be noted that sensory characteristics are also important factors driving consumer acceptance and hence repeated consumption.

1. Introduction

Consumer demand for safe, fresh, healthy, and natural foods has been increasing in the last two decades (Timmermans et al., 2011). This has led to the development of non-thermal processing technologies such as high hydrostatic pressure processing (HPP) and pulsed-electric fields (PEFs) as an alternative to the conventional thermal processing to inactivate microorganisms and prolong product shelf-life (Timmermans et al., 2011). HPP involves the application of hydrostatic pressure above 100 MPa while PEF uses high-voltage pulses (Frewer et al., 2011; Hicks et al., 2009). These technologies offer the advantage of retaining the sensory and nutritional properties close to those of the unprocessed product with limited or no use of chemical additives (Arvanitoyannis, 2006).

Commercial applications of HPP technology at ambient temperature have been successfully demonstrated in a wide range of food products such as seafood, avocado-based products, fruit and vegetables products, beverages, meat products, dairy products, ready-to-eat meals, sauces and spreads (Campus, 2010). Currently, commercial HPP treated food products are widely available in U.S., U.K., Europe, and Japan (Norton & Sun, 2008). Regarding PEF, the first commercial application of this technology approved by U.S. Food and Drug Administration was commercialized in 2006 for fruit juice processed by Genesis Juice Cooperative (Clark, 2006). Although recently, other companies such as Hoogesteger and Fruity King (the Netherlands), True Fruits (Denmark), and Orchard House (U.K.) have been using PEF technology to treat fresh juice (Töepfl, 2013), most applications of PEF treatment in the food industry are restricted to fruit juices due to technical and commercial limitations (Töepfl, 2013).

With 1.35 billion inhabitants and a gross domestic product of 8.3 trillion U.S. dollars (Statista, 2013), China offers tremendous

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opportunities for food manufacturers and exporters to develop value-added products that satisfy Chinese consumers' needs. Recent research has reported that Chinese consumers are becoming more health conscious and are switching from soft drinks to fruit juices (Euromonitor, 2013; Granato, Branco, Nazzaro, Cruz, & Faria, 2010). This trend of consuming fruit juices is likely to continue with increasing disposable incomes and education levels (Euromonitor, 2013). HPP and PEF technologies have the potential to develop fruit juices that meet Chinese consumers' demand for safe products without compromising flavor, freshness, naturalness, and nutritional value. In China, HPP processed food products introduced to consumers include blueberries, fruits, vegetables, pickled foods, sauces and seafood (Baotou KeFa, 2011; Sharma, 2011). While PEF treated foods have not been commercially introduced in China, Chinese research groups are working on industrial applications of PEF processing (particularly liquid foods) (Feng, Wang, & Xu, 2013). Large-scale introduction of HPP and PEF products will soon take place in China. To achieve product market success in China, it is critical to understand how consumers perceive the food and beverage products treated by these technologies.

Chinese consumers' perceptions of non-thermal technologies and their treated products have been studied by Lee, Lusk, Mirosa, and Oey (2015). Consumers in their study were generally open-minded and receptive towards HPP and PEF technologies (Lee et al., 2015). They seemed to appreciate the benefits of HPP and PEF technologies (e.g. kill microorganisms, extend product shelf-life, and preserve the product's flavor, color and nutritional content without the need of additives), and were willing to pay a premium price for their treated products (Lee et al., 2015). However, the study by Lee et al. (2015) did not take into account the sensory perceptions of food products treated by the HPP and PEF technologies. Sensory characteristics such as flavor are important factors driving consumption and repeat purchase behaviors (Cardello, Schutz, & Lesher, 2007).

Nonetheless, consumers' perceptions of food products do not depend solely on the intrinsic sensory characteristics of the products (Asioli, Næs, Granli, & Lengard Almli, 2014; Menichelli, Olsen, Meyer, & Næs, 2012; Varela, Ares, Giménez, & Gámbaro, 2010). As tasting is typically not permitted at the point of purchase, consumers have to rely on the products' extrinsic attributes such as brand, origin, packaging, nutrition, price and information (Lee & Lou, 2011). Several studies have demonstrated that information could have a large impact on consumers' perceptions and liking of food products (Stolzenbach, Bredie, Christensen, & Byrne, 2013; Varela et al., 2010). In particular, information regarding the processing technology and how it affects the food products has been reported to increase both Western (Brazil, Italy, U.S., Norway, Denmark, Hungary and Slovakia) and Chinese consumer acceptance and likelihood of purchase towards the treated food products (Caporale & Monteleone, 2004; Cardello, 2003; Deliza, Rosenthal, & Silva, 2003; Lee et al., 2015; Olsen, Grunert, & Sonne, 2010; Sonne et al., 2012).

Before tasting the product, information generates hedonic and sensory expectations that can positively or negatively influence consumers' perceptions (Cardello, 1994; Deliza & MacFie, 1996). High expectations will likely lead to the consumer choosing the product, whereas low expectations will lead to product rejection (Cardello, 1994). After choosing and tasting the product, the expected sensory and hedonic characteristics are compared to the real ones, leading to confirmation and disconfirmation of expectations (Deliza & MacFie, 1996). A mismatch between expectations and actual product performance would lead to positive or negative disconfirmation, depending on whether the product is better or worse than expected, respectively (Cardello, 1994). Negative disconfirmation can lead to consumer rejection of the product (Deliza & MacFie, 1996). Thus, information about consumers' expectations of the product is important to gain a holistic understanding of consumer acceptance.

While extant literature presents consumers' perceptions of non-thermal processing technologies and their treated products (Lee et al., 2015; Nielsen et al., 2009), limited information is available regarding the effects of both intrinsic and extrinsic product attributes and their interactions on consumer acceptance of these treated products (Cardello, 2003; Deliza et al., 2003), particularly with regards to Chinese consumers. This study examined the effects of technology information on Chinese consumers' acceptance of thermal and non-thermal treated apple juices. Specifically, Chinese immigrant consumers in New Zealand were used as the sample population. Apple juice is one of the most popular juices in China, second only to orange juice (Euromonitor International, 2015). The insights gained in this study will expand the body of knowledge on consumer perception of food processing technologies, especially in a non-Western setting.

2. Materials and methods

2.1. Apple juice preparation

New Zealand Jazz apples (150 kg, harvested in 2014) were transported to the Department of Food Science, Dunedin, New Zealand where they were stored at 4 °C and used within 2 weeks of arrival. Prior to juicing, all apples were washed with 100 ppm chlorinated water for 1 min (Hypostat 135, Wilsons Chemicals, Christchurch, New Zealand) and rinsed with distilled water to eliminate any microorganism contamination. One quarter of the washed apples was stored under refrigeration (~4 °C) to prepare the freshly squeezed juice (further called untreated juice). Untreated juice was prepared on the day of the consumer study and used as a control to compare with thermal, HPP and PEF treated juices.

The remaining washed apples were juiced using a Breville Juice Fountain (model JE90, Breville, Sydney, Australia) The juice was then sieved (0.5 mm) to remove the pulp and transported to a storage tank that was stored at ~4 °C until processing occurred (within 12 h of juicing).

The freshly squeezed apple juice was divided into three equal portions with each portion subjected to one of the following treatments: thermal, HPP and PEF. Processing conditions for each of the three treatments were selected to result in an equivalent microorganism inactivation (4 logs) to achieve a four week shelf-life when stored at 4 °C.

Thermal treatment (72 °C, 15 s) of the apple juice was conducted using a continuous tubular heat exchanger (inner diameter of 10 mm, length of 200 cm) at a flow rate of 16 L/h. The juice was immediately cooled to 13 °C using a continuous tubular heat exchanger (inner diameter of 10 mm, length of 100 cm). The cooled juice was packed in pre-sterilized polyethylene Whirl-Pak plastic bags (300 mL, Nasco, Fort Atkinson, WI, USA) under hygienic conditions in a laminar flow cabinet where the packages were vacuum sealed.

For HPP treatment, the untreated juice was vacuum packed in pre-sterilized polyethylene Whirl-Pak plastic bags. The juice samples were subjected to 600 MPa of pressure for 3 min using industrial scale HPP equipment (HPP 055, Multivac, Sepp Haggenmüller GmbH & Co., Wolfertschwenden, Germany). Water was used as the pressure medium. The inlet temperature of the water was maintained at 7–8 °C. The pressure build up was conducted at 125 MPa/min. The pressure release was conducted in two stages: instantaneous pressure decrease from 600 to 50 MPa, followed by step-wise decompression from 50 MPa to ambient pressure within 60 s.

PEF treatment of apple juice was carried out using a PEF system (Elcrack®, HVP-5, DIL, German Institute of Food Technologies, Quakenbrück, Germany) in a continuous mode over a co-linear treatment chamber, with an internal diameter of 10 mm and a gap of 10 mm between the electrodes (titanium, grade: 3.7035), using bipolar square wave pulses. The treatment was carried out with a pulse width of 20 μs, frequency of 48 Hz, flow rate of 16 L/h, electric field strength of 15.5 kV/cm and specific energy of 158 kJ/L. The conductivity of the apple juice ranged between 1.5 and 1.7 mS/cm (CyberScan CON 11, Eutech Instruments, Singapore). A digital oscilloscope (UTD2042C, Uni-Trend Group Ltd, Hong Kong) was used to analyze the width and shape of pulses. The temperature inside the PEF chamber was monitored using fiber optic sensors and ranged between 87 and 98 °C. The juice kept at 4 °C was pre-heated to 30 °C using a continuous tubular heat exchanger (inner diameter of 10 mm, length of 100 cm). After PEF treatment, the juice was immediately cooled to 19 ± 1 °C by circulating the juice in a chilled water jacket around the assembly. The PEF-treated juice was packed in pre-sterilized polyethylene Whirl-Pak plastic bags under hygienic conditions in a laminar flow cabinet and vacuum sealed.

Following processing, samples from the three treatments were immediately stored at 4 °C until consumer evaluation (within three days after processing). One hour prior to evaluation, 20 ml of each sample was poured into opaque plastic portion cups (50 ml) with lids. The current study has been purposely designed to collect consumers' overall acceptance of the apple juices and no attempt was made to hide the differences in the appearance of juices. Two different sets of samples were prepared: one for the blind tasting and another for the informed tasting. All samples were coded with three digit codes and randomized to account for sample order and carry-over effects (Macfie, Bratchell, Greenhoff, & Vallis, 1989). The randomized sets of samples were stored at ~10 °C until evaluation.

Table 1
Socio-demographic profiling of consumers in the acceptance test (n = 118).

Characteristics	Percentages (%) n = 118
Gender	
Male	44.07
Female	55.93
Age	
18–29	85.59
30–39	7.63
40–49	2.54
⩾70	4.24
Marital status	
Single	65.25
Dating/engaged/partner	15.25
Married, without children	11.02
Married, with children	5.93
Other	2.54
Occupation	
Professional	2.54
White collar	5.93
Student	83.90
Housewives	1.69
Unemployed	5.93
Annual income (RMB)	
<10,000	12.71
10,000–29,999	5.93
30,000–59,999	4.24
60,000–89,999	4.24
90,000–149,999	3.39
150,000–299,999	0.85
⩾300,000	0.85
No fixed income	63.56
Other	4.24
Education level	
Senior high school	7.63
Diploma	6.78
Bachelor	44.07
Postgraduate	41.53

2.2. Experimental protocol

2.2.1. Consumer selection

One hundred and eighteen consumers (55.93% female, 44.07% male) were recruited from University campuses and public places around the city center of Auckland, New Zealand during August 2014. The majority of the consumers were students (83.90%) and between 18 and 29 years old (85.59%) (Table 1). For this study, consumers were restricted to individuals of Chinese ethnicity from mainland China living in New Zealand for two years or less, who were over 18 years old and consumers of apple juices. The criterion of two years or less was to ensure consumers have not been substantially influenced by New Zealand culture. An apple juice consumer was defined as an individual who consumed apple juice at least once in the three months prior to participating in the study. Recruitment of participants was restricted to the Chinese immigrants in New Zealand as there was no PEF equipment available for juice production in China. It was also not realistic to export the juices to China for consumer testing due to no existing agreement between New Zealand and China for food safety regulation around non-thermal processing technologies. Young and educated consumers were recruited for this study as they have been identified as being particularly health conscious and interested in purchasing healthy food products (Lau, Chan, Tan, & Kwek, 2012; Zakowska-Biemans, 2011). Ethical approval was granted by the University of Otago and Auckland University of Technology Human Ethics Committee (reference numbers: 13/271, 13/338).

2.2.2. Consumer evaluation

Four apple juices (untreated, thermal, HPP and PEF treated) were evaluated in three testing conditions: (a) blind (rating acceptance of the apple juices without any information), (b) label (rating acceptance of the apple juice labels containing different technology information without tasting the juices), and (c) informed (rating acceptance of the apple juices by tasting the juices and observing the labels containing different technology information). The "blind-label-informed" method will add useful information to studies on consumers' perceptions of non-thermal treated apple juices, as this method will allow potential mismatches between technology information and sensory characteristics to be detected.

Data were collected through self-administered paper questionnaires written in Mandarin. A pilot questionnaire was administered to eight local native Mandarin speaking Chinese in Dunedin, New Zealand to verify that the instruction, construct and language use was correct. The questionnaire was back translated to identify any further language concerns.

Consumer testing was conducted over three consecutive days at Auckland University of Technology, New Zealand. Testing was carried out in a sensory laboratory with individual booths under artificial daylight type illumination, with temperature control (between 22 and 24 °C) and air circulation.

Upon arrival at the laboratories, consumers were directed into the booth, where informed consent was obtained. Consumers then completed three hedonic evaluations in the following order: blind, label and informed.

For the blind evaluation, consumers were monadically presented the four apple juices and asked to rate the acceptability of each juice on separate 150 mm hedonic line scales anchored at 10, 75, and 140 mm with "dislike extremely", "neither like nor dislike" and "like extremely", respectively. Unstructured hedonic line scale was selected for this study as it is a commonly applied acceptance method for consumer testing and it can eliminate concerns of unequal category spacing (e.g. in the case of nine-point hedonic scale) (Hein, Jaeger, Tom Carr, & Delahunty, 2008). Before presenting the next sample, consumers were instructed to take a 30 s break and rinse their palate with water.

For the evaluation of the labels, consumers rated their acceptance for apple juice labels with different technology information without tasting the juices. This was done to understand if the provision of product labels containing technology information would affect consumers' hedonic expectations and acceptance of the treated juices. The use of labels mimicked the situation usually faced by consumers at the supermarket, where product decisions are based on examination of the packaging. The label information varied in regards to the processing technology, price and shelf-life, depending on the technology used to treat the apple juices (Lee et al., 2015; Timmermans et al., 2011) (Table 2). As mentioned earlier in the introduction section, HPP and PEF technologies can retain the sensory and nutritional properties close to the unprocessed product as compared to the thermal processing (Arvanitoyannis, 2006). Aguilar-Rosas, Ballinas-Casarrubias, Nevarez-Moorillon, Martin-Belloso, and Ortega-Rivas (2007) reported that thermal processing condition for pasteurization has a negative impact on the quality of apple juices resulting in the loss of fresh natural flavor. Nielsen et al. (2009) commented that the products manufactured by HPP and PEF technologies are expected to be more expensive than the conventional processed products on the market. In addition, HPP and PEF treated juices were reported to have a relatively shorter shelf-life than thermally treated juices (Nielsen et al., 2009). The other features of the labels such as brand name, manufacturing country, additive and nutritional information were kept identical across all product labels (Lee, Lusk, Mirosa, & Oey, 2014; Leybovich, 2012). The product label information was established from expert opinions, group meetings, and a review of literature. Fig. 1 presents an example of the labels (HPP treated juice) used in the study.

As the differences in each apple juice label were subtle, a rank-rating approach was used (Ishii, Chang, & O' Mahony, 2007). This was done to encourage consumers to compare the labels (Ishii, Chang, & O' Mahony, 2007). All four apple juice labels were presented simultaneously to the consumers in random orders. Consumers were asked to rank the samples for increasing acceptance (least acceptable to most acceptable). Consumers were then instructed to rate the overall acceptance of the four juice labels on the same 150 mm hedonic line scale used in blind condition. Consumers were allowed to re-examine the juice labels and change their rank order and acceptance as many times as necessary. Ties were allowed at both ranking and rating stages.

For the informed evaluation, consumers were monadically presented the four apple juice samples in random order, alongside with their corresponding juice label. This was done to understand the impact of both sensory characteristics and technology information on consumers' acceptance of apple juices. Consumers were instructed to taste the sample, examine the juice label, and rate their overall acceptance on the same 150 mm hedonic line scales used in blind condition. Before presenting the next sample, consumers were instructed to take a 30 s break and rinse their palate with water.

The last part of the consumer questionnaire gathered demographic information including gender, age and occupation. Upon completion of the questionnaire, NZD 10 (∼USD 8) was given to each consumer. Each questionnaire was approximately 20 min in duration.

Table 2
Descriptions used on the study's apple juice labels (back-translated English versions).

Label	Employed technology and description	Price (RMB)	Shelf-life
Untreated	Freshly squeezed, maintaining the fresh taste and nutrition	17	3 days
Thermal	Heat pasteurized, providing longer shelf-life while protecting the juice's nutrition	13	9 months
HPP	High pressure processed, providing longer shelf-life while maintaining the juice's fresh taste and nutrition	17	30 days
PEF	Pulsed-electric field treated, providing longer shelf-life while maintaining the juice's fresh taste and nutrition	17	30 days

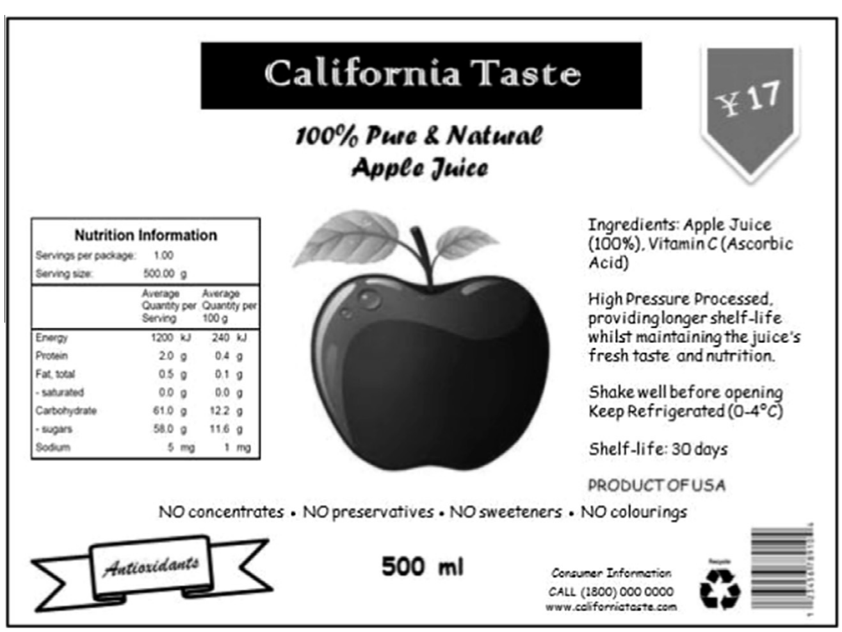

Fig. 1. An example of the apple juice labels (HPP treated juice) used in the study (back-translated English versions).

Table 3
Mean acceptance scores (±standard deviation) for the four juice samples, for the three evaluation conditions: blind, label and informed ($n = 118$).

Sample	Evaluation condition (mm)		
	Blind ($F_{3,351} = 5.162$, $p = 0.002$)	Label ($F_{3,351} = 71.985$, $p < 0.001$)	Informed ($F_{3,351} = 34.728$, $p < 0.001$)
Untreated ($F_{2,234} = 10.213$, $p < 0.001$)	$98 \pm 28.12^{b,A}$	$110 \pm 29.75^{c,B}$	$111 \pm 27.00^{c,B}$
Thermal ($F_{2,234} = 41.068$, $p < 0.001$)	$86 \pm 30.52^{a,C}$	$56 \pm 30.84^{a,A}$	$75 \pm 29.04^{a,B}$
HPP ($F_{2,234} = 3.749$, $p = 0.025$)	$87 \pm 31.22^{a,A}$	$94 \pm 23.49^{b,AB}$	$95 \pm 27.75^{b,B}$
PEF ($F_{2,234} = 3.905$, $p = 0.021$)	$86 \pm 30.24^{a,AB}$	$84 \pm 29.82^{b,A}$	$93 \pm 27.60^{b,B}$

Different lowercase superscripts within a column indicate significant differences according to Tukey's test ($p \leqslant 0.05$).
Different capital superscripts within a row indicate significant differences according to Tukey's test ($p \leqslant 0.05$).

2.3. Data analysis

To study the effect of technology information on consumers' acceptance, analysis of variance (ANOVA) was performed on overall acceptance scores considering sample, evaluation condition and the interaction between sample and evaluation condition as fixed sources of variation (SPSS Inc, Chicago, IL, USA) (Varela et al., 2010). A second ANOVA was performed on blind, label and informed acceptance scores separately, considering consumer and sample as the fixed sources of variation to determine if the samples varied in acceptability within each evaluation condition. When differences were significant, Tukey's HSD test was performed. The significance levels for all tests were examined at the 5% level.

The individual consumer responses to each apple juice under the blind, label and informed conditions were analyzed by the internal preference mapping using a principal component analysis on the correlation matrix of consumer individual acceptance data using XLSTAT (version 2014, Addinsoft, Paris, France). The resulting preference maps were expressed as scatter plots of samples and individual consumers in relation to the first two principal dimensions.

In order to determine if the acceptance scores for each sample varied across the three evaluation conditions, a third ANOVA was performed on consumers' acceptance scores considering evaluation condition and consumer as fixed sources of variation. When differences were significant, Tukey's HSD test was performed. The significance levels for all tests were examined at the 5% level. Another internal preference mapping analysis was also carried out on the difference in acceptance ratings between the blind and informed conditions to determine how consumers changed their acceptance after being provided the technology information.

A fourth ANOVA was also performed on consumers' acceptance scores considering gender and consumer as fixed sources of variation. When differences were significant, Tukey's HSD test was performed. The significance levels for all tests were examined at the 5% level.

To identify if distinct segments of consumers exist, the consumers' acceptability scores were subjected to cluster analysis. Segmentation was performed using an Agglomerative Hierarchical Cluster Analysis by the Euclidean distance for the dissimilarity scale by the Ward's method (SPSS version 21, SPSS Inc., Chicago, USA).

3. Results

3.1. Effect of information on mean acceptance for apple juices

Overall, there was a significant effect of the evaluation condition on consumers' acceptance scores ($F_{2,1404} = 8.103$, $p < 0.001$), indicating that technology information had a significant influence on consumers' acceptance of apple juices. The interaction between sample and evaluation condition was also significant ($F_{6,1404} = 12.608$, $p < 0.001$), indicating that the degree in which consumers' acceptance of the juices was dependent on the available technology information.

The four apple juice samples varied in acceptance in each of the three evaluation conditions (Table 3, $p < 0.05$). In the blind condition ($F_{3,351} = 5.162$, $p = 0.002$), the untreated apple juice was on average the most acceptable sample ($\bar{x} = 98$ mm), and significantly different from the thermal ($\bar{x} = 86$ mm), HPP ($\bar{x} = 87$ mm) and PEF ($\bar{x} = 86$ mm) treated samples. The three processed juices (thermal, HPP and PEF) were not different in acceptance, suggesting the respective processing treatments resulted in equal acceptability.

In the label condition ($F_{3,351} = 71.985$, $p < 0.001$), the untreated sample was the most acceptable ($\bar{x} = 110$ mm), and significantly different from the other samples. The HPP ($\bar{x} = 94$ mm) and PEF ($\bar{x} = 84$ mm) treated samples were not different in acceptability, while the thermal ($\bar{x} = 56$ mm) treated sample was the least acceptable and significantly different from the other samples. This suggests that consumers' hedonic acceptance were influenced by the given technology information.

In the informed condition ($F_{3,351} = 34.728$, $p < 0.001$), samples were discriminated similar to the label condition with the untreated juice ($\bar{x} = 111$ mm) being the most acceptable, followed by HPP ($\bar{x} = 95$ mm) and PEF ($\bar{x} = 93$ mm), while the thermal ($\bar{x} = 75$ mm) treated juice was the least acceptable.

3.2. Effect of information on internal preference maps for apple juices

An internal preference map of consumers' overall acceptance scores for the blind condition is shown in Fig. 2. The first two principal components explained 70.88% of the variability of the data. Consumers were equally distributed on the map, revealing homogeneity in their acceptance for untreated, thermal, HPP and PEF treated samples.

An internal preference map for consumers' label acceptance scores is shown in Fig. 3. The first two principal components explained 87.49% of the experimental variability. The greatest percentage of explained variation in the label condition suggests that the consumers were able to discriminate the apple juices better than the blind and informed conditions. This might be due to the provision of apple juice labels with different technology information that has resulted in more explained variation. Most consumers were mainly located to the right side of the map, reflecting their acceptance towards the untreated sample. The thermal treated sample was located in quadrant two where the density of consumers decreases, implying the least acceptable sample. Both HPP and PEF treated samples negatively loaded along dimension two and were perceived to be acceptable by different subgroups of consumers.

An internal preference map of consumers' overall acceptance scores for the informed condition is shown in Fig. 4. The first two components explained 76.72% of the experimental variability. Consumers were mainly located to the right side of the map showing clear preference for the untreated juice, while the thermal treated

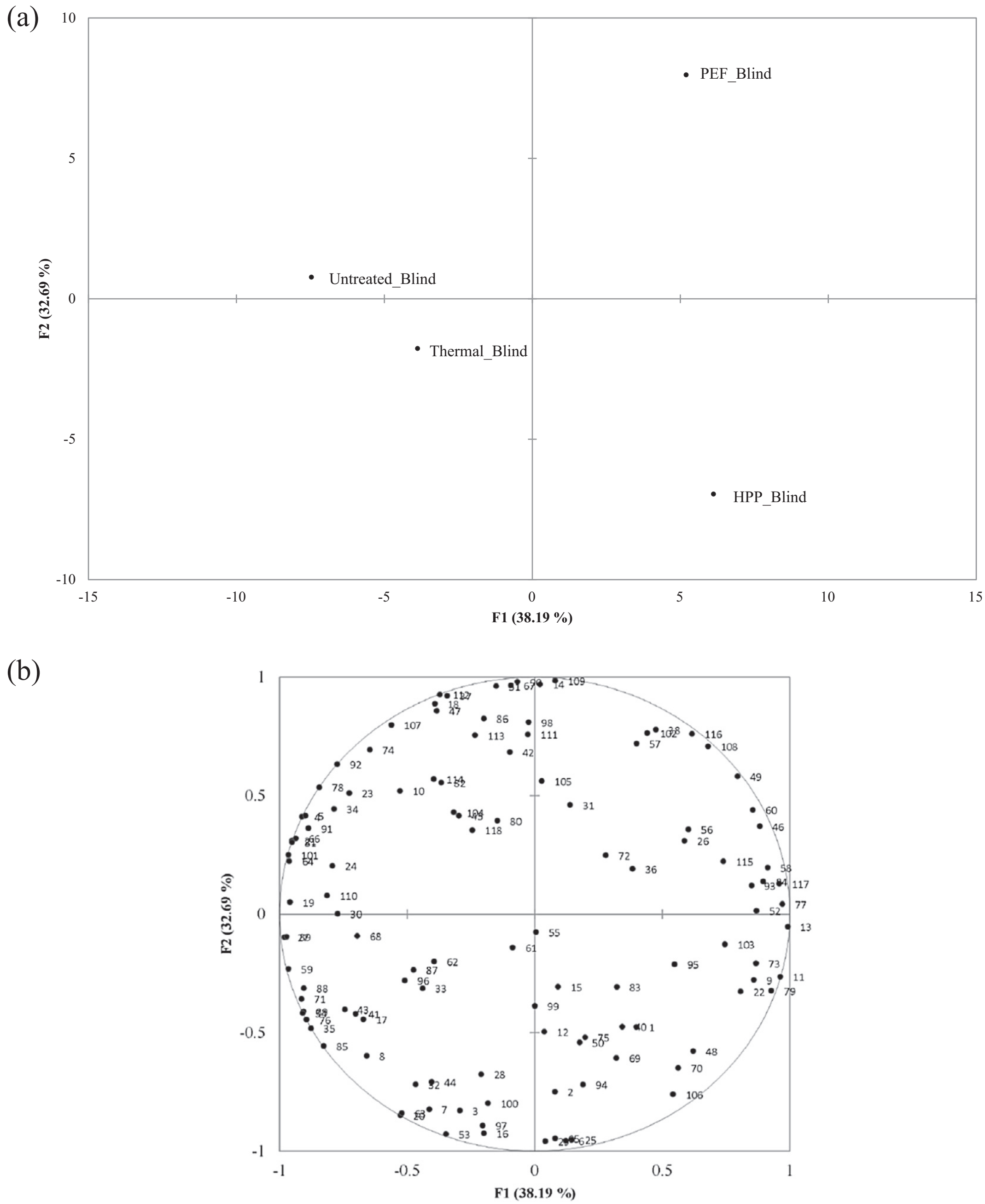

Fig. 2. Internal preference map of consumers' blind acceptance scores of the four evaluated apple juices: (a) samples' representation and (b) consumers' representation ($n = 118$).

juice was the least acceptable sample along dimension one. HPP and PEF treated samples were located at the negative side of dimension two and found acceptable to an average number of consumers. This preference map is different from the one built with the blind scores, showing the large impact of technology information on consumers' acceptance.

3.3. Comparison of mean acceptance ratings among blind, label and informed conditions

When comparing acceptance ratings from the blind ($\bar{x} = 98$ mm) and label ($\bar{x} = 110$ mm) evaluation conditions, a negative disconfirmation (product less acceptable than expected) occurred for the untreated juice. This would suggest, consumers had higher hedonic expectations as a result of the technology information (Table 3). The largest differences between acceptance ratings in the blind ($\bar{x} = 86$ mm) and label ($\bar{x} = 56$ mm) evaluation conditions were observed for thermal treated sample. A positive disconfirmation (product more acceptable than expected) occurred for thermal treated juice, where technology information had significantly decreased consumers' hedonic expectations of the product. For HPP and PEF treated samples, the acceptance scores for the labels were not significantly different from blind acceptance scores, indicating a good fit between sample expectation and sensory appreciation.

Comparing blind and informed tasting conditions, consumers significantly increased their acceptance scores on the informed condition for untreated and HPP treated juices (Table 3). This indicates that when consumers' hedonic expectations generated by the technology information were not fulfilled by the samples' sensory

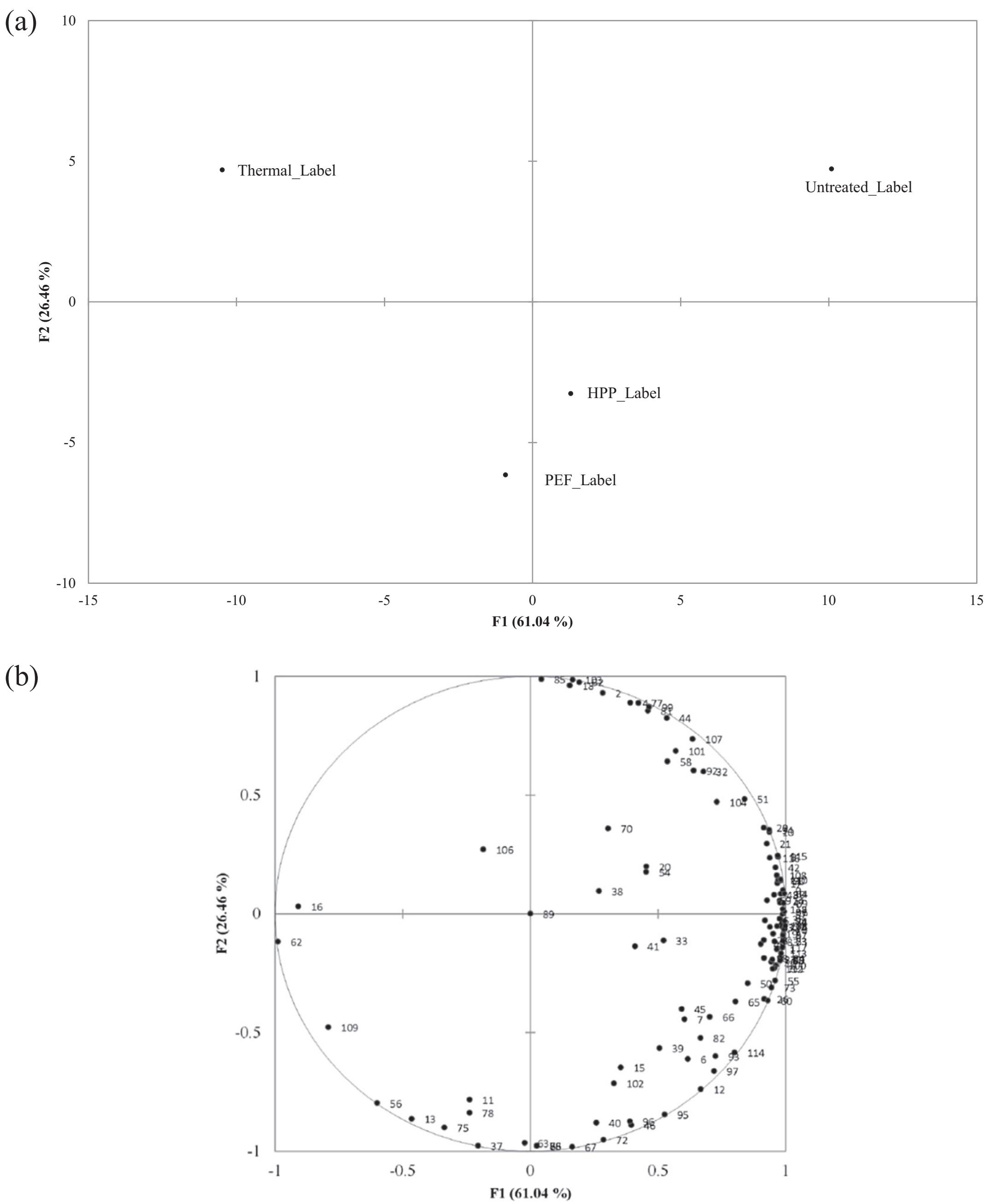

Fig. 3. Internal preference map of consumers' label acceptance scores of the four evaluated apple juices: (a) samples' representation and (b) consumers' representation ($n = 118$).

characteristics, assimilation of disconfirmed hedonic expectations took place. Thus, consumers increased their acceptance scores in the informed condition with respect to the blind tasting condition, indicating a positive influence of the technology information on consumers' acceptability of these samples. Additionally, the difference between informed and label scores was not significant for untreated and HPP treated juice, confirming that expectations generated by technology information exerted the strongest influence on the informed acceptability scores for these samples.

In contrast, technology information did not have a significant impact on consumers' acceptability of PEF treated sample as the acceptance scores under blind and informed tasting conditions were not significantly different. This suggests that technology information had a neutral effect on consumers' acceptance of PEF treated apple juice. Additionally, technology information significantly lowered consumers' acceptance scores for thermal treated juice, suggesting that information negatively influence their acceptance on the treated products. For thermal and PEF treated juices, significant differences were observed between informed and label scores. This reveals that consumers did not fully assimilate acceptance towards the technology information and sensory characteristics had an impact on the informed acceptability scores of the thermal and PEF treated apple juices.

The importance of technology information on individual consumer acceptance of apple juices is shown in the internal preference map of the difference between informed and blind ratings (Fig. 5). The first two components explained 70.08% of the experimental variability. The higher density of consumers in the direction of untreated and HPP treated samples suggests that consumers changed their ratings mostly for these samples when

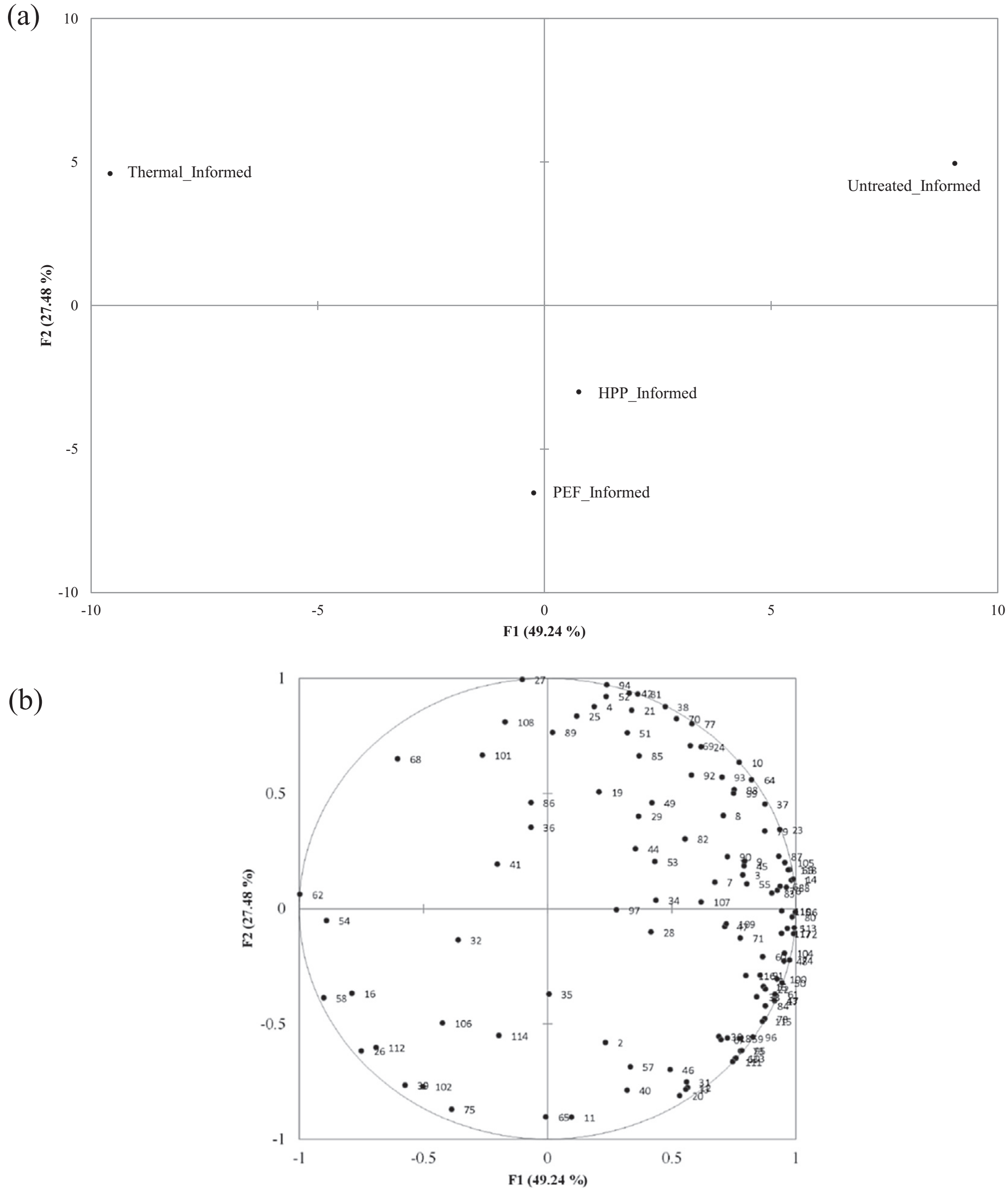

Fig. 4. Internal preference map of consumers' informed acceptance scores of the four evaluated apple juices: (a) samples' representation and (b) consumers' representation (n = 118).

provided technology information. Most consumers disfavored thermal treated apple juice when they were presented with technology information. Along dimension two, a small segment of consumers changed their ratings for PEF treated juice when given the technology information. These findings are consistent with the results from mean acceptance data.

In addition, ANOVA results showed that there was no significant gender effect on consumers' acceptance of apple juices treated using different processing technologies within each evaluation condition: blind ($F_{3,464}$ = 0.419, p = 0.740), label ($F_{3,464}$ = 0.778, p = 0.507), and informed ($F_{3,464}$ = 1.342, p = 0.260).

Cluster analysis identified three groups of consumers with distinct preferences towards the apple juices (Fig. 6). Cluster 1 was the largest group with 47.46% of the consumers (n = 56). The consumers in this cluster preferred the untreated samples at all three evaluation conditions the most, followed by HPP and PEF treated juices evaluated in the informed condition, and disliked the thermal treated samples at label and informed conditions. Cluster 2 was the smallest of the partition and includes 22.03% of the consumers (n = 26). Similar to Cluster 1, consumers in Cluster 2 showed a preference for the untreated juices at all three evaluation conditions. However, Cluster 2 did not seem to appreciate the HPP and PEF treated juices (particularly in the label condition). Instead, they preferred the thermal treated juices at blind and informed conditions. Cluster 3 comprised of 30.51% of the consumers (n = 36). Cluster 3 consumers preferred the HPP and PEF treated juices the most, in particular the label and informed conditions. They also disliked the thermal treated samples at all evaluation conditions. Hence, the cluster analysis results suggest that consumers in the Cluster 1 and 3 tended to be more receptive towards HPP and PEF treated juices especially when the technology information was provided, as compared to Cluster 2.

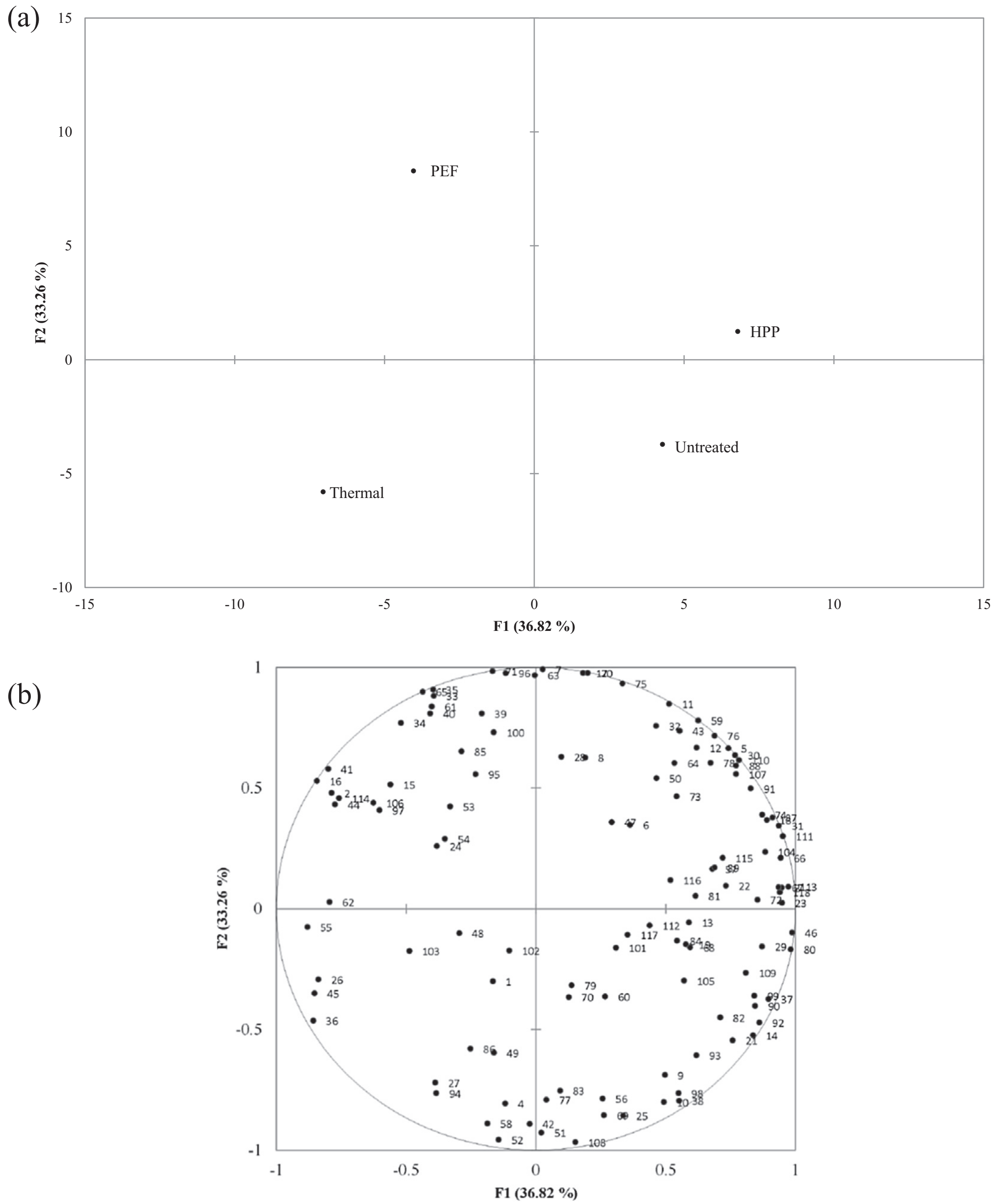

Fig. 5. Internal preference map of the difference in acceptance ratings of four evaluated apple juices between the informed and blind tasting conditions: (a) samples' representation and (b) consumers' representation ($n = 118$).

4. Discussion

4.1. Effect of information on consumer acceptance of apple juices processed by different technologies

Untreated apple juices were consistently rated as the most acceptable sample across the three evaluation conditions. This corresponds to the previous study where food safety incidents in China have caused consumers to lose confidence in food products, creating demand for fresh, natural and minimally processed foods and beverages (Foster, 2011). Similarly, Olsen et al. (2011) showed that although European consumers perceived HPP and PEF treated juices to be a better choice than thermal treated juice, most of the consumers still want freshly produced juice with a premium taste at an acceptable price.

For the processed juices (thermal, HPP and PEF), consumers in the present study were found to equally accept these samples during the blind condition. However, consumers increased or maintained their acceptance scores for HPP and PEF treated juices respectively when the technology information was provided. Acceptance ratings for thermal treated juices were lowered when consumers were given the technology information. Hence, the findings of this study suggest that technology information had a positive or neutral effect on consumers' acceptance for HPP and PEF treated juices, whereas information had a negative influence on consumers' acceptance for thermal treated juice.

It is interesting to note that technology information significantly lowered consumers' acceptance scores for thermal treated juice, regardless of the cheaper price and longer product shelf-life. This suggests that the young Chinese immigrant consumers

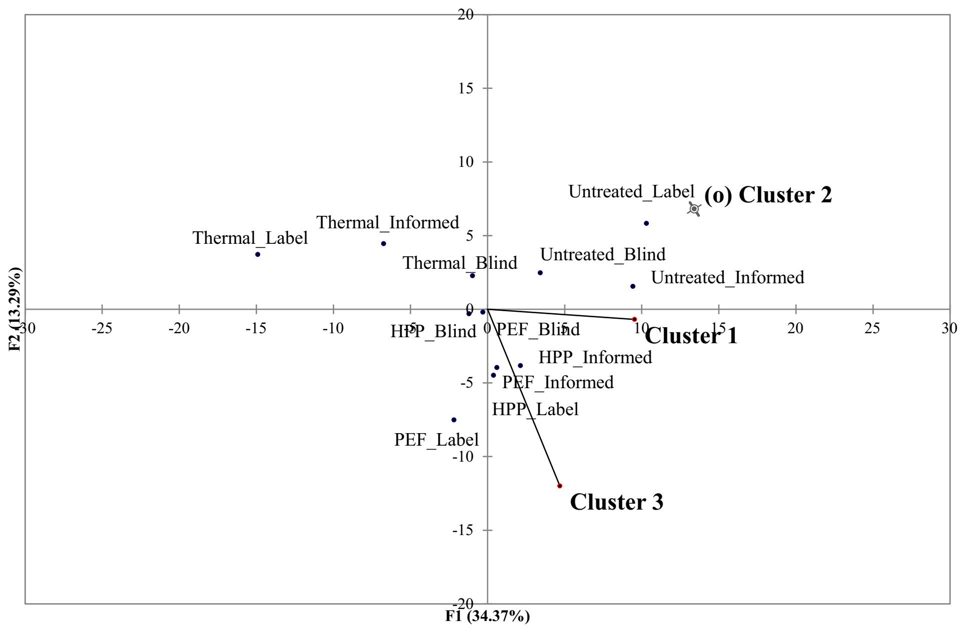

Fig. 6. Internal preference map of the consumers' acceptance ratings of four evaluated apple juices across blind, label, and informed conditions and grouping as determined by cluster analysis ($n = 118$).

in New Zealand might have pre-existing knowledge on thermal processing and this knowledge tended to influence their acceptance on the treated products negatively. The current findings are opposed to the study by Cardello (2003) where thermal processing has been found to evoke the least concern among U.S. consumers and generated the highest expected acceptance when compared to other novel technologies such as irradiation, ultrasound, HPP and PEF. Lee et al. (2015) found that Chinese consumers were familiar with the thermal processing and expressed trust towards the technology. However, consumers were concerned with how high temperatures changed a product's nature including its flavor and nutritional quality (Lee et al., 2015). Despite the low expected acceptance score, the sensory properties of thermal treated apple juices were good enough to minimize the negative effect of information on acceptability. This assimilation effect has been observed in the study by Stolzenbach et al. (2013) that showed product information did not fully determine consumer acceptance for apple juices. Nevertheless, the lowest acceptance scores for thermal treated juice in label condition might be confounded by the effect of the use of rank-rating. The extra checking of the product labels in the rank-rating procedure might have allowed improved perception of differences in intensity among the samples (Ishii, Chang, & O' Mahony, 2007). Furthermore, it should be noted that the use of rank-rating in the label condition might have carry-over effects in the informed condition and hence affect consumers' acceptance scores of the apple juices.

While Chinese consumers in the present study were receptive towards HPP and PEF technologies, the technology information seemed to be more successful in influencing consumers' acceptability for HPP than PEF. Lee et al. (2015) found that Chinese consumers were skeptical towards the name 'pulsed-electric field' and uncertainty about the harmful side effects associated with PEF. As HPP was perceived to be a more "natural" technology than PEF, the technology was perceived to be more acceptable to the Chinese consumers (Lee et al., 2015). Similar findings have also been observed with Western consumers (U.S., U.K., Europe and Australia) (Butz et al., 2003; Delgado-Gutierrez & Bruhn, 2008; Nielsen et al., 2009; Olsen et al., 2011; Sonne et al., 2012).

From these results, it can be concluded that technology information plays an important role in influencing young Chinese consumers' perceptions of the apple juices. This is in agreement with previous consumer studies on powdered drinks (Varela et al., 2010), where a complete assimilation effect was observed for information (i.e. brand), suggesting that consumer acceptance scores were dictated by their expectations.

4.2. Implications for fruit juice manufacturers targeting the Chinese market

Food manufacturers should include the information of processing technologies on the product packaging during the development of HPP and PEF treated products, especially when targeting young and urban Chinese consumers. With the current voluntary labeling policy for HPP and PEF technology information in China (EU SME Centre, 2013), most food manufacturers choose not to include this information on food products to prevent "technology scares" among consumers such as in the case of genetically modified products (Gruère & Rao, 2007). However, Lee et al. (2015) found that most Chinese consumers still preferred the technology information on the product label even though it is 'too technical'. Additionally, the principles of these technologies and their benefits on food products could also be provided to Chinese consumers in detailed brochures or videos. Providing detailed technology information to consumers has been found to decrease their perceived risk and increase trust towards the products of the technology (Cardello, 2003; Lee et al., 2015).

Apart from the technology information on product labeling, the product's sensory characteristics also contribute to consumers' positive perceptions of HPP and PEF treated foods. Free samples could be distributed to Chinese consumers in the retail outlets to allow consumers to experience the product themselves thereby improving the likelihood of acceptance towards HPP and PEF treated products.

In comparison to British, German and European consumers who were not willing to pay more for the HPP treated products (Butz et al., 2003; Olsen et al., 2011), higher priced non-thermal processed apple juices were perceived to be acceptable to the young Chinese consumers in the present study. This might be due to the fact that the Chinese consumers appreciated the benefits offered by HPP and PEF technologies (e.g. kill microorganisms, extend product shelf-life, and preserve the product's flavor and color). As suggested by Lee et al. (2015), Chinese consumers placed less emphasis on the price for HPP and PEF treated beverages. For example, 90% of the studied Chinese consumers were willing to purchase HPP and PEF treated healthy beverages even if they were sold at a 10% premium compared to a conventionally treated product. Therefore, the pricing strategy for HPP and PEF treated products can potentially be set 10–30% higher than conventionally processed products in China. This recommendation is supported by literature that has also suggested that an emerging segment of high-end consumers is willing to pay a modest premium for nutritious, safe and quality food products in China (Lee et al., 2015; Xu, Zeng, Fong, Lone, & Liu, 2012).

In the present study, a within-subject design was used to investigate the effect of technology information on each consumer's acceptance of apple juices in three evaluation conditions: blind, label and informed. Therefore, demand effects cannot be completely ruled out. Further investigation is required to determine if a between-subject design (where each consumer evaluates only one testing condition) can produce similar results as obtained by this study.

5. Conclusions

The current study has addressed the importance of technology information in influencing Chinese consumers' acceptance of processed apple juices. Consumers were relatively homogeneous in their acceptance for the apple juices during blind tasting condition. However, consumers' acceptance changed in label and informed conditions depending on the available technology information. This suggests that blind tasting alone might not adequately predict consumers' affective reaction to apple juices. Technology information should be taken into account during new product development for HPP and PEF treated juices as the information could positively affect a consumer's expectations for and acceptance of a product.

It is important to note that the current study focused on young and urban Chinese immigrant consumers living in New Zealand for two years or less. Hence, results should be interpreted within the context of this study and they are not necessarily representative of the greater Chinese population. Exploration of the validity of these findings in a wider and more representative setting in China is warranted. In addition, the current study investigated consumers' perceptions of apple juices treated using thermal, HPP and PEF technologies. Hence, consumers' acceptance scores may vary in different food matrices and when treated using other food technologies and parameters. Further investigation of Chinese consumers' perceptions of other types of food and beverage products and processing technologies is recommended. In addition, the "blind-label-informed" approach could be further improved by adding, for example, check-all-that-apply questions to gather insights into consumers' perceptions of the food processing technologies.

The findings revealed in this study are useful for the fruit juice industry and food marketers to effectively develop and devise a better marketing strategy for non-thermal treated food and beverages targeting Chinese consumers. In addition, the results of this study showed a clear indication that food policy makers need to pay more attention to effectively regulating and implementing the label of technology information for non-thermal treated food products.

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