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USE OF HASS AVOCADO (*Persea americana* Mill.) SEED AS A PROCESSED PRODUCT

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Avocado seeds are a waste product in the pulp and oil production and represent, in Hass, about 12% of the fruit weight.
In this study a product was developed that can be used as a snack. Ripe avocado fruits with 11% oil content were deseeded, and the seeds were dried and milled. This milled powder was evaluated, according to its percentages of: dry matter, total solids, lipids, protein, ash fibre, total carbohydrates and calories $100g^{-1}$. Then the dry sample was split into two parts. The first part was blended with milled corn at 40 - 60% (avocado-corn). The second part was taken as control and was not mixed. Both treatments were treated in a Wenger X 20 single screw extrusion system. The obtained product was compared with a commercial snack. The yield was 8.4 % and the appearance and adhesion were good. The results are showing a product with water content of 8%, density 212.5 g L^{-1}, water absorption index 6.89 g g^{-1}, solubility in water 4.69 g $100g^{-1}$, gelatinization 95.25%. The final product showed low levels of trypsin inhibitors.

Key words: extruded, snack, gelatinization, discarded avocados, proximal analysis

UTILIZACIÓN DE LA SEMILLA DE PALTA (*Persea americana* Mill.) CV. HASS COMO PRODUCTO AGROINDUSTRIAL

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La semilla de palta en la actualidad constituye un descarte de los procesos de elaboración de pulpas y de aceite, constituyendo en el cv Hass alrededor del 12% del peso del fruto.
En el presente estudio se desarrolló, con semilla del cv Hass, un producto extruído, posible de ser consumido como “snack”. Para ello, a paltas maduras con más de 11% de aceite se les extrajo la semilla y ésta se secó y se molió. A esta semilla molida se le determinó porcentaje de humedad, sólidos, lípidos, proteínas, cenizas, fibra, carbohidratos y calorías 100 g^{-1}. Luego la muestra seca

fue dividida en dos partes. La primera fue mezclada con maíz molido, en proporción de 40-60% (palta-maíz) y la segunda, testigo, no fue mezclada. Ambos tratamientos fueron sometidos a un extrusor Wenger X20 de tornillo, donde se obtuvo un producto extruído, el cual fue comparado con un snack comercial. El rendimiento obtenido fue de 8,4% y se obtuvo para ambos tratamientos un extruído de buena apariencia y grado de adhesión. Los resultados muestran que el producto tuvo los siguientes parámetros: Humedad 8%; Densidad 212,5 g L^{-1}, Índice absorción agua 6,89 g g^{-1}, Índice solubilidad en agua 4,69 g $100g^{-1}$, Gelatinización 95,25 %. Los extruídos de semilla obtenidos presentaron bajos niveles de inhibidores de tripsinas.

Palabras clave: extruido, snack, gelatinización, descartes de palta, análisis proximal

1. Introduction

Once the edible pulp is separated, the skin and seed are left as residues. The seed has lower lipid content than pulp; therefore, lipids are not considered important in processes such as the obtaining of oil. However, Mazliak (1965) and Lee (1981) found that the fatty acids in the seed have higher levels of polyunsaturated acids than in the pulp.

In addition, enzymes and substances with antibiotic and antimicrobial characteristics may be found in the stone. The latter would have a possible use in canned meats, curing processes and in the preservation of confectionery creams. The seed may be also used to extract tannins and pigments. Furthermore, avocado stones may have some compounds that avoid the browning of the fruit (Canto, 1980).

Kahn (1987) states that avocados seeds are a potential starch source due to their content around 30%. He also mentions that the microscopic evaluation of this element showed the presence of characteristics similar to those of corn. The parameters of gelatinization and viscosity are from type C (restricted dilation), which suggests their possible use in food that must be heated up at 100°C (212°F), such as soups and sauces.

The avocado seeds have some anti-nutritional characteristics such as hydrocyanic acid, cyanogenic glycosides, condensed polyphenols and some tannins, which could act adversely on their possible use. However, the great majority of those substances are thermolabile; therefore, a suitable heat treatment (cooking) would destroy them (OAS, 1978; Deshpande and Salunke, 1982; Schmdit and Hebbel, 1986).

Studies on the antimicrobial ability of an extract in avocado seed acetone determined that it has an antibacterial effect on *S. aureus*, *B. subtillis*, *Aspergillus glaucus* and *Penicillium notarum*, but it did not show any effects on *E. coli* and *Pseudomonas fluorescens* (Neeman, 1970).

The use of avocado seed to elaborate an extruded product to be used as snacks may be a way out to the discards generated in the industrialisation of avocados.

In the present trial, the chemical characteristics of seeds from Hass and Fuerte avocados harvested on two maturity stages were evaluated, determining the quality of a product extruded of Hass avocado seed comparing it with a commercial snack.

2. Materials and methods

At the Experimental Station La Palma of the Faculty of Agricultural Sciences, Pontificia Universidad Católica de Valparaíso, located in the city of Quillota (Latitude 32° 49' S, Longitude 71° 16'W), 20 kg of Fuerte avocado and 100 kg of Hass avocados were harvested. In both varieties, "unripe fruit" was harvested; 10 kg of Fuerte variety with 3.23% oil and 10 kg of Hass variety with 5.1% oil; and fruit designated as "ripe", 10 kg of Fuerte cultivar with 13% oil and 90 kg of Hass variety with 19.5% oil.

From each cultivar and on each maturity stage, the seeds were obtained (2 kg of Fuerte variety for each maturity stage; 1 kg of "unripe" Hass avocados and 15 kg of "ripe" Hass avocados); these seeds were washed with water. From these seeds, 1-kg samples of each maturity stage and variety were taken, using them for the measuring of proximal analysis.

For the characterisation of seeds from each variety and maturity stage, a proximal analysis was conducted, determining the following parameters: % moisture (A.O.A.C., 1980); % Proteins (Kjeldahl method; % nitrogen x 6.25) (A.O.A.C., 1980); % ashes (A.O.A.C., 1980); % ether extract (total lipids) (A.O.A.C., 1980); % nitrogen-free extract (total carbohydrates) (A.O.A.C., 1980); and % fibre (A.O.A.C., 1980).

For the manufacturing of an extruded product, only "ripe" seeds from Hass varieties were used. The remaining 14 kg of seeds from the previous measuring were dried for 2 to 3 hours through drying machine at 65°C (149°F). Subsequently, they were grinded and milled in a grinding mill, generating a granulated product, whose drying was finished in a drying machine at 65°C until reaching 15% moisture. The percentage of starch from these milled and dried seeds was determined (A.O.A.C, 1980).

For the extrusion of stones, two processing tests were conducted: the first one with a mixture of seed and corn in proportion of 40% - 60%; the second one with 100% seed of dried and milled avocado. In both cases, a total amount of 10 kg was used, size of nominal lower limit sample for the good operation of extruder. The loss of material in the equipment does not exceed 5%. An equipment of pilot extrusion of the brand Wenger X20 was used; and the extrusion conditions are shown in Table 1.

According to the results of the previous processing, it was determined that the stone moisture decreased from an average of 50% to 6% after the drying process. This means that approximately 0.5 kg of milled stone can be obtained from each kilogram of fresh stone.

Table 1: Conditions of extrusion operation of avocado seed

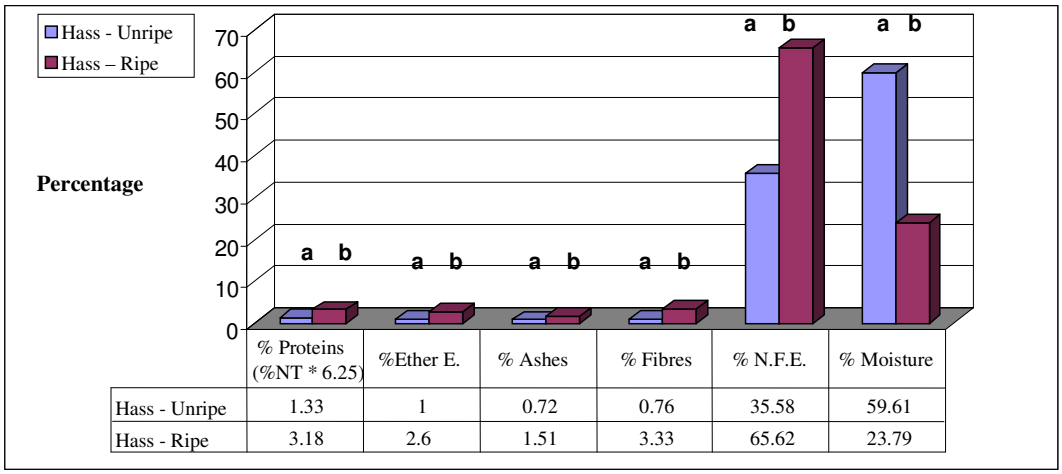
Parameter	**40/60% avocado - corn**	**100% seed avocado**
Variety	Hass	Hass
Initial weight of fresh stone (kg)	8	20
Drying conditions	2-3 h. 60-65°C	2-3 h. 60-65°C
Product to be processed (kg)	4	10
Corn added (kg)	6	0
Moisture of dried milled stone (%)	6	6
Conditions of the extrusion		
Process time	5 minutes	5 minutes
Die	Conical 2 perforations 4 mm diameter	Conical 2 perforations 4 mm diameter
Number of cutters	7	4
Speed of cutters	Position 7	Position 7
RPM screw	Position 2 (394 RPM)	Position 2 (394 RPM)
Feed	Position 6	Position 7
Pre-conditioner	Position 7	Position 4,5
Number of jackets	3 (with water)	2 (with water)
Temperature last jacket	70°C	90°C
Pre-conditioner rotameter	10 m^3/s	25 m^3/s
Jacket rotameter	15 m^3/s	30 m^3/s
Estimated losses	5 %	5 %

The quality of the avocado-extruded product obtained was also compared with a commercial product. In addition, the existence of anti-nutritional characteristics, trypsin inhibitors and tannin content (polyphenols) was determined in seeds of Hass avocados, in the milled and dried seed as well as in the extruded product to verify the presence and their thermolability with the extrusion process.
A microbiological analysis was also conducted.

3. Results and discussion

Proximal analysis of seeds from Fuerte and Hass avocados on two maturity stages

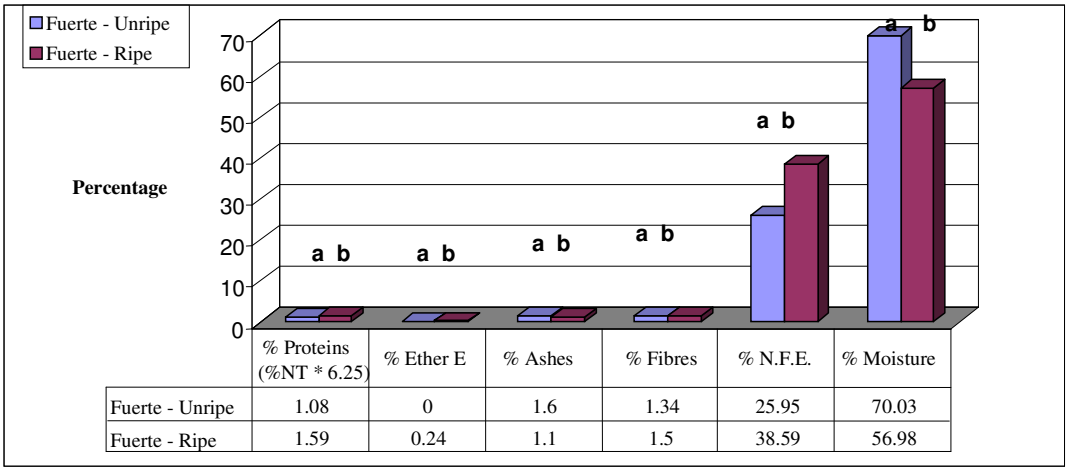
The results obtained for each average parameter in both varieties are illustrated in Figures 1 and 2.



	% Proteins (%NT * 6.25)	%Ether E.	% Ashes	% Fibres	% N.F.E.	% Moisture
Hass - Unripe	1.33	1	0.72	0.76	35.58	59.61
Hass - Ripe	3.18	2.6	1.51	3.33	65.62	23.79

*The same letters in each parameter do not show any significant differences according to Tukey Test p ≤ 0.05.

Figure 1: Percentage evolution of protein, ether extract, ashes, nitrogen-free extract and moisture in stones of Hass avocado.



	% Proteins (%NT * 6.25)	% Ether E	% Ashes	% Fibres	% N.F.E.	% Moisture
Fuerte - Unripe	1.08	0	1.6	1.34	25.95	70.03
Fuerte - Ripe	1.59	0.24	1.1	1.5	38.59	56.98

*The same letters in each parameter do not show any significant differences according to Tukey Test p ≤ 0.05.

Figure 2: Percentage evolution of protein, ether extract, ashes, nitrogen-free extract and moisture in stones of Fuerte avocado.

Regarding the percentage of proteins, it may be observed that this is higher in those seeds coming from ripe avocados. When comparing the varieties, the Hass seeds showed a higher level of proteins than the Fuerte seeds.

In the measurement of Ether Extract (measurement of fatty matter), it may be noticed that the Hass variety shows a higher level of fatty matter than that coming

from Fuerte. In addition, in both varieties, the seed coming from ripe fruits had a higher level of fat matter, because of the energy that the seed needs for its germination. This situation causes that seeds coming from ripe avocados would be more likely to suffer rancidity and possibly be affected by a higher oxidation capacity, especially in the formation of dark melanoid compounds.

The fibre percentage of seeds increased in riper fruits; however, it had a higher rate in Hass variety than in Fuerte.

When analysing the percentage of ashes, a different behaviour may be noticed between these varieties. In Hass variety, the ash percentage was higher in ripe fruits, unlike Fuerte variety.

Regarding the Nitrogen-Free Extract (carbohydrates), the maturity stage of the fruits and the cultivar also affected its level. Seeds from riper fruits had a higher level of carbohydrates, because the seed is a structure that needs energy during germination.

When considering that a great percentage of carbohydrates in the avocado seed are constituted by starch, the Hass cultivar is regarded as the best option to achieve a good quality of extrusion.

In regard to moisture, this decreases as the fruit ripened. This is caused by the increase of nutrients previously analysed.

Snack Manufacturing

The starch analysis of Hass avocado seed determined a content of 41.3%. This analysis fits in with the data obtained from bibliography, where a percentage around 30% on wet basis is estimated to be used for extrusion.

The characteristics of extruded products obtained are shown in Table 2.

Table 2: Moisture (%), Density (g/L), water absorption rate (g/g), rate of solubility in water (g/100g) and Gelatinisation (%) of two products extracted on basis of avocado seed and commercial product.

Parameter	40/60% (Avocado/Corn)	100% Avocado	Commercial snack product
Moisture (%)	8	3.02	1 - 5
Density (g/L)	212.5	303	100-220
Water absorption rate (g/g)	6.89	4.88	1 -5
Rate of solubility in water (g/100g)	4.69	18.95	10 - 40
Gelatinisation (%)	95.25	80.66	70-97

According to the data obtained, for every 100 kg of avocado, around 16.5 kg of fresh stones may be generated, and from these, after processing, around 8.8 kg

of dried milled stone is obtained. The extrusion had efficiency around 95%, eventually obtaining 8.4 kg of extruded product.

Regarding the extrusion conditions for the two trials conducted, no problems of excess of product stuck on the equipment were detected, but operation with higher temperatures was necessary when working only with stones.

In the extrusion of stone alone, a type of snack product, less swollen than the product mixed with corn, is obtained. If pressure is applied, this stone "snack" is disintegrated more easily than the material, resulting in a powder. This may be caused by lower moisture content of the product alone compared with that mixed with corn.

When comparing the product obtained with 100% of avocado seeds with a commercial snack, it is observed that this showed characteristics very similar to the commercial product, except for its higher density. Meanwhile, the stone/corn extrusion in proportion of 40/60% showed results out of the limits mentioned and would require a subsequent drying to reduce its moisture levels to more stable values, although its gelatinisation percentage falls into normal figures.

The result of the microbiological and anti-nutritional analyses is shown in Table 3.

The microbiological analyses showed values of low total count of bacteria for both products. In the evaluation of anti-nutritional factors, the presence of both substances in the powder product was detected before being extruded, but in concentrations about 10 times lower than those normally seen in legumes. The results clearly indicate that the extrusion is a medium to destroy such substances or reduce them to minimum levels, due to the heat treatment established in the operation.

Table 3: Anti-nutritional factors and microbiological quality of dried and milled avocado seed and avocado seed extrusion: 40/60% (avocado/corn) and 100% avocado.

Parameter	**Dried milled seed**	**Extrusion 40/60% (Avocado/Corn)**	**Extrusion 100% Avocado**
Moisture (%)	6	8	3.02
Trypsin inhibitors (UTI /g sample)	13400	30.18	30.95
Tannins (gr/100gr)	0.1	< 0.01	0.01
Total count (UFC/g)		200	7000

4. Conclusions

The levels of proteins in Fuerte and Hass avocados are higher in ripe fruits.

The Hass stones showed a starch content above 30%.

It is possible to obtain from the Hass avocado stones snack alone or combined with corn with a low total count of bacteria.

The extrusion is a medium to destroy trypsin inhibitors and tannins or to reduce them to minimum levels, in avocado seed. However, this requires an extra drying.

The Hass avocado seed provides a good quality to the product obtained

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