

WHEAT VARIETAL FLOURS: INFLUENCE OF PECTIN AND DATEM ON DOUGH AND BREAD QUALITY

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The effect of two additives, high methoxyl pectin (P) and the emulsifier diacetyl tartaric acid esters of monoglycerides commonly named DATEM (D) and their mixture (P+D) on dough properties and baking performance of two varietal Argentinean wheat flours ('Buck Pronto' [BP]; 'Klein Escudo' [KE]) was analyzed. Rheological characterization of dough (alveogram, farinograms, texture profile analysis-TPA, and rheometric assays), with and without additives, was performed. SEM was used to evaluate the microstructure of dough. Baking performance was analysed by bread volume measurements, shape ratio of loaves (width/height), and the hardness of crumb and crust. Assays on dough showed differences in alveographic force (W) and in most of the texture profile analysis parameters. Assays on bread showed that BP specific volume was improved with the addition of P and P+D, but shape ratio was only improved with the mixture of P+D. Breads from KE flour with additives presented, in all cases, showed higher volumes and a better shape ratio than those obtained with the control sample. Hardness of KE crumb was diminished by all additives but BP crumb was softened only with the addition of P and P+D. All sensory parameters were improved for both types of bread, particularly with D and P+D.

Keywords: Wheat cultivars, Wheat dough, Food additives, Rheological properties, Breadmaking quality, Sensory evaluation.

INTRODUCTION

Within protein composition of a wheat flour varietal, the insoluble proteins, glutenins (of high and low molecular weight), and gliadins, exhibit a unique profile that allows their identification. These proteins confer to flours' particular characteristics, and it is well known that they have a straight influence in dough and bread quality. During kneading, addition of water and mechanical energy produce interactions between proteins leading to gluten network formation, whose particular characteristics will depend on the protein profile of each type of flour, other ingredients, and the fixed process variables.^[1]

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Annual wheat production of Argentina comprises flours obtained from many types of cultivars, harvested in diverse environmental conditions. As a consequence, flour quality varies upon the interaction genotype-environment. Commercial flours are the result of mixing two or more wheat varieties, mainly during the stocking process. Thus, even when a great number of varieties are available, differences become masked resulting in a lower profit from the genetic diversity.^[2] The increasing offer of industrial baking products requires wheat grains of constant quality. The use of flours from different wheat varieties, with a predictable performance, result in a way to fulfil this requirement.

In bread making, the use of additives has become a common practice to ensure an acceptable product.^[3] In Argentina, up to 1995, potassium bromate was widely used since it produces a more resistant dough by its oxidizing effect. Since that year, its use is forbidden by law and it has been replaced by other additives or mixtures of additives, with a diverse effect on Argentinian common commercial flours. Many types of additives, such as oxidants, emulsifiers, hydrocolloids, and enzymes, are available. The most known effect of emulsifiers is a general strengthening on wheat dough. Among the emulsifiers, an anionic oil-in-water one, diacetyl tartaric acid ester of monoglycerides (DATEM), has been shown to modify the resistance and extensibility of dough by different proposed mechanisms.^[4] Hydrocolloids have deserved more attention in the recent year as baking improvers; they have been reported to affect dough characteristics and water binding capacity as well as quality of the final product. Besides, due to the high hydrophilic properties of these molecules, water migration in the finished product would be prevented, therefore increasing their shelf life.^[5-12] Among hydrocolloids, high methoxyl pectin is considered a soluble fiber, forms firm gels at low concentrations, and is widely used in jellies and similar products. Its application on bread making could be interesting from both a nutritional and technological point of view. Masoodi and Chauhan^[13] studied the application of apple pomace (containing 13% w/w pectin) as a source of dietary fiber in wheat bread. They reported that this ingredient could be incorporated in breads up to 5% without a drastic change in bread quality parameters. However, literature about the microstructural changes induced by pectin addition is scarce. Bárcenas et al.^[6] found that pectin induced a reduction of gluten quantity (wet gluten, dry gluten) and gluten quality (gluten index) parameters, indicating a weakening effect of this hydrocolloid on the gluten structure. Upon Ribotta et al.,^[7] this effect is due to the possible interaction with gluten proteins that interferes with the formation of the gluten network.

In a previous work,^[14] the performances of two Argentinian wheat varietal flours ('Buck Pronto' and 'Klein Escudo') and their mixtures were analyzed and compared to each other. These genotypes were found to have quite different characteristics and performance due to their different gliadins and glutenins profiles. According to Cuniberti,^[2] these two varieties belong to different groups adequate for different types of breadmaking. 'Buck Pronto' varietal (Buck Semillas S.A., Argentina) belongs to Group 1 (superior quality), with alveographic W ranging between 340 and 600, P/L > 1, and wet gluten > 27%. The farinographic stability usually ranges between 15 and 40 min. These types of wheats are used for industrial breadmaking, rendering the highest bread volumes. The 'Klein Escudo' varietal (Criadero Klein S.A., Argentina) belongs to Group 2 (special quality), with alveographic W values ranging between 240-340 and P/L between 0.7-1. For this group, farinographic stability values are expected to be between 10 and 15 min and wet gluten is >25%. Flours from this group are intended for traditional Argentine breadmaking (fermentation periods >8 h).^[2] The previous knowledge of varietal flours' properties provide a basic step to understand the behavior of these flours in the presence of additives.

The objective of the present work was to analyze the effect of two different additives on dough properties and baking performance of the flours obtained from the above-mentioned varietal Argentine wheat.

MATERIALS AND METHODS

Materials

Two cultivars of wheat (*Triticum aestivum* L.) were chosen because of their different bread-making quality: 'Buck Pronto' (Buck Semillas S.A., Argentina) and 'Klein Escudo' (Criadero de Semillas Klein, Argentina). Grains were conditioned before milling at a final moisture of 15.5% and milled in automatic MLU-202 Bühler equipment (Bühler AG, Uzwil, Switzerland). Flours were characterized in a previous work.^[14] Flour protein contents were 10.15%, (SD = 0.04) and 9.66% (SD = 0.01) for BP and KE, respectively.^[14] Additives assayed as flour improvers were a high metoxile pectin (P) at a level of 1%, and the emulsifier diacetil tartaric acid esters of monoglycerides, DATEM (D) at a level of 1.5%. A blend of both additives was also utilized (HMP 1% + DATEM 1.5%, named as P+D). As control samples, flours (F) without additives were utilized.

Farinographic and Alveographic Tests

A Brabender farinograph (50 g capacity) (Brabender, Duigsburg, Germany) and a Chopin alveograph (Chopin, Villeneuve-la-Gavenne, Cedex, France) were used for rheological characterization of wheat flour blends according to official methods.^[15,16]

Dough preparation. Each flour blend (300 g), NaCl (6 g), and enough water (obtained from farinographic data) were mixed during 7 min (1 min at 160 rpm and 6 min at 215 rpm speed rate) in a small scale kneader (Arno BPA, 5 speeds, SEB Group, Sao Paulo, Brazil). Final dough temperature was 23–25°C. Dough was covered with plastic film to avoid water losses, and was left to rest for 30 min at 30°C. In order to improve gluten development, dough was laminated 12 times, turning dough 90 degrees each two passages. After that, dough was sheeted to 1 cm height and left rest for 10 min at 30°C.

Instrumental texture profile analysis (TPA) of dough. Cylindrical samples (30–40 pieces) of 2 cm diameter and 1 cm height were obtained from dough. Dough texture parameters were evaluated using a TA.XT2i Texture Analyzer (Stable Micro Systems, Surrey, UK) with a software Texture Expert for Windows, version 1.2. Dough was allowed to relax 15 min at 20°C before testing and then was submitted to two cycles of compression up to 70% of the original height with a cylindrical probe (diameter = 7.5 cm). Force-deformation curves were obtained at a crosshead speed of 0.5 mm/s. Product hardness, adhesiveness, elasticity, and cohesiveness were determined in 30 replicates according to Bourne.^[17] Hardness is defined as the maximum force registered during the first compression cycle. Adhesiveness is the negative area obtained during the first cycle. Cohesiveness was determined as the ratio between the positive area of the second cycle and the positive area of the first cycle. Elasticity was calculated as the distance between the beginning and the maximum force of the second compression cycle.

Dynamic rheometry of dough. Cylindrical pieces (2 cm diameter, 0.5 cm height) of the different dough were submitted to dynamic rheological measurements. Measurements were performed in a Haake RS600 oscillatory rheometer (Haake, Karlsruhe, Germany) at $30 \pm 0.1^\circ\text{C}$, using a plate-plate sensor system with a 1.5-mm gap

between plates. Two types of rheological tests were assayed:^[14] (a) deformation sweeps (0.5–200 Pa) at constant frequency (1 Hz) to determine the maximum deformation (γ_{\max}) a sample can experience in the linear viscoelastic range, and (b) frequency sweeps (from 0.005 to 100 Hz) at constant deformation (5 Pa) within the linear viscoelastic range. Mechanical spectra were obtained recording the dynamic moduli G' , G'' , and $\tan \delta$ (G''/G') as a function of frequency. G' is the dynamic elastic or storage modulus, related to the material response as a solid, while G'' is the viscous dynamic or loss modulus, related to the material response as a fluid. $\tan \delta$ is related with the overall viscoelastic response: low values of this parameter indicate a more elastic sample.

Scanning electron microscopy (SEM). Cylindrical dough samples (2 mm diameter \times 2 cm height) were immersed in 2.5% glutaraldehyde and then washed with phosphate buffer 0.5 M before the dehydration process. Samples were dehydrated in a grade acetone series: 25, 50, 75, and three times with 100%. Drying of samples was performed at the critical point with the intermediate CO_2 fluid. Samples were then coated with gold in a sputter coater (Pelco, Redding, USA). They were observed at 5 kV voltages in a JEOL JSM 35 CF microscope (Tokyo, Japan) scanning electron microscope.

Dough preparation. Pure varietal flours or blends with additives (300 g) were mixed with an aqueous solution of NaCl (6 g) and dispersion of fresh yeast (9 g). Salt and yeast were previously dissolved, each one separately, in the half amount of the corresponding farinographic water. Ingredients were mixed in the kneader (Arno BPA, 5 speeds, SEB Group, Sao Paulo, Brazil) during 7 min (1 min at 160 rpm and 6 min at 215 rpm speed rate). After the mixing process, temperature of the dough was between 23 and 25°C. The dough was covered with plastic film to avoid dehydration, and left to rest for 30 min at 30°C. Then, the dough was laminated 12 times, turning the dough 90° after two consecutive passages. The dough was then sheeted to 1 cm height and left to rest 10 min at 30°C. Round pieces (35–40) were cut with a cylindrical mold (4.8 cm in diameter). The dough pieces were placed in baking trays sprayed with water and left for 45 min at 30°C for leavening. Another water spray was done before entering into the oven. The pieces were baked in an oven without steam (Ariston Type FIB-EM-IN-03, Model FM87 FC, Ariston, Le-Marche, Italy) at 200°C, during 13 min. Three bread makings were performed. Pieces of bread like heart buns were obtained. Thirty pieces were used as replicates for each sample measurement.

Bread characteristics. The bread volume was determined by seed displacement in a loaf volume meter. To calculate the specific volume (cm^3/g), the ratio between bread volume and the weight of each piece was determined. Height and width of each piece was also measured. The ratio between width and height (W/H) was calculated. Hardness was obtained by compression assays, using a plate-plate sensor system with a stainless cylindrical probe SMSP/75 (diameter 7.5 cm). A degree of compression of 30% of height at a speed of 0.5 mm/s was used, using a TA-XT2i texture analyzer (Stable Micro Systems, Surrey, UK). Crumb samples presented a dimension of 2 cm diameter and between 2 and 3 cm of height. Assays were performed on 30 replicates of each sample.

Bread samples (30 pieces) were analyzed by means of a puncture test in a TA-XT2i texture analyzer (Stable Micro Systems, Surrey, UK). Bread pieces were covered with a linen cloth and left for 1 h at room temperature before measuring crust firmness. The samples' crust was penetrated in two different points up to 8 mm from crust surface with a needle stainless probe SMSP/3 Stable Micro Systems, Surrey, UK, at a constant velocity of 0.5 mm/s. The penetration force and time needed to reach the first peak maximum were determined from force-time curves.

The sensorial quality of bread was evaluated. Control bread (BP and KE) and bread prepared with additives (P, D, and P+D) were analyzed. A test of attributes-acceptability was performed. Appearance, flavor, crumb and crust texture, and overall acceptability was assayed. Tests were performed with a non-trained panel of 40 people, using a hedonic scale of 10 points. Scores ranged from “Dislike very much” (score 1) to “Like very much” (score 10). The panelists group was composed of 60% females and 40% males of ages between 25 to 55 years old.

Statistical Analysis

Results were subjected to a one-way analysis of variance according to the general linear model procedure with least-square means effects. A multiple range test was applied to determine which means were significantly different according to Fisher’s least significant differences (LSD). Statistical analysis was carried out using an InfoStat program (InfoStat, 2004 version, Grupo InfoStat, FCA, Universidad Nacional de Córdoba, Argentina).

RESULTS AND DISCUSSION

Rheological and Microstructure Characteristics of Dough

Cultivars used in this study exhibited different high molecular weight glutenins (HMW-GS) profile. While the BP varietal had the subunits 7 and 8, the KE varietal didn’t have the subunit 8 and instead it exhibited a subunit 9.^[14] This different profile renders a gluten network of different quality, with the BP variety being the strongest one. Thus, flour from ‘Buck Pronto’ (BP) formed a dough with alveographic W values higher than ‘Klein Escudo’ (KE) (Fig. 1). The tenacity of BP and KE exhibited a tendency to increase with the presence of additives; while extensibility showed the opposite trend. As a consequence, the ratio tenacity/extensibility increased in the presence of additives for both varietals (Fig. 1). All additives (P, D, P+D), especially the emulsifier, decreased the alveographic W parameter in both kinds of dough (BP and KE) but to a different extent depending on the varietal type.

Farinographic water absorption presented, for both kinds of flours, a tendency to increase with the addition of the hydrocolloid, and no differences between control samples were observed for flours with DATEM (data not shown). Farinographic stability did not show a unique trend respect to the additives assayed. For BP dough, this parameter was increased by the addition of D and decreased with P, while KE dough stability markedly decreased (between 28 and 31%) with both of them (Fig. 1). The combined action of pectin and the emulsifier (P+D) led to softer dough and decreased stability in both flours. This behavior could be due to a potentiated effect of a hydrophilic additive (pectin) that binds polar sites and a hydrophobic molecule (DATEM) that has affinity by hydrophobic sites of proteins and/or starch. These results indicate that the effect of a certain additive would be dependent on the varietal flour in which it is applied. Differential action of DATEM, depending on the type of flour was also found by Ravi et al.^[18] These authors found that the use of emulsifiers increased the resistance to extension and decreased the extensibility of dough, being this effect greater with DATEM. With respect to pectin, it was reported by Bárcenas et al.^[6] that the addition of this hydrocolloid in increasing levels led to a significant reduction of gluten index, dry gluten, and wet gluten, suggesting a weakened gluten network. This weakening effect is, in general, in agreement with our results for alveographic force and farinographic stability.

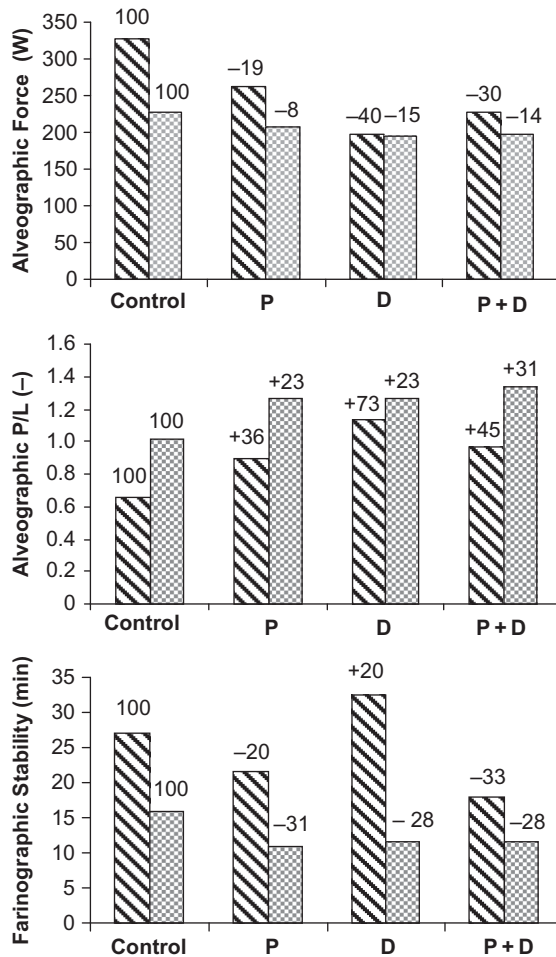


Figure 1 Alveographic W values and farinographic stability of flours without additives (control) and with HMP, DATEM, or P+D. Column codes: scratched, BP; crosshatched, KE. Numbers over columns indicate the percentage decrease respect to control.

Figure 2 shows texture properties of dough. When comparing varietal flours without additives, BP dough exhibited higher values of hardness than KE dough but it was less adhesive, cohesive, and elastic. From the different textural attributes of dough, the most relevant tendencies were found in hardness and elasticity. Interestingly, additives had different effects on varietals: for BP flour they decreased hardness and increased elasticity, while for KE flour the opposite effect was detected. Furthermore, adhesiveness of both kinds of dough increased with additives, while cohesiveness increased only for BP. In general, the mixture P+D did not improve the effect on texture quality observed with the addition of D alone.

Oscillatory assays, at small deformation in the linear viscoelastic range, have been the preferred mode of fundamental rheological characterization for wheat flour dough for several researchers.^[19–21] BP and KE presented similar values of G' (Fig. 3). The incorporation of additives significantly decreased the elastic modulus (G') of BP dough, being these results in accordance to the tendency observed in alveographic W and hardness (Figs. 1

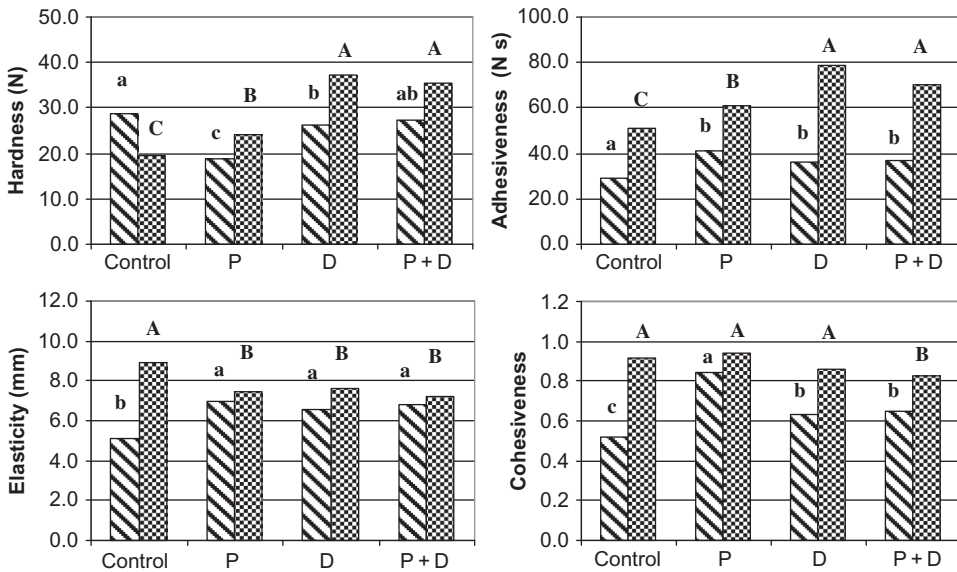


Figure 2 Textural attributes: hardness, adhesiveness, elasticity, and cohesiveness of flours without additives (control) and with HMP, DATEM, or P+D. Column codes: scratched, BP; crosshatched, KE. Different letters in the same varietal flour indicate significant differences ($P < 0.05$). BP hardness: lsd 1.40; BP adhesiveness: lsd 6.23; BP elasticity: lsd 0.82; BP cohesiveness: lsd 0.06; KE hardness: lsd 3.11; KE adhesiveness: lsd 9.31; KE elasticity: lsd 0.56; KE cohesiveness: 0.09.

and 2, respectively). Among additives, the most marked effect on G' of BP dough was observed with pectin. Bárcenas et al.^[6] also found that pectin increased G' and G'' but $\tan \delta$ remained constant indicating a stable contribution of both the elastic and the viscous components. In our case, pectin did not either significantly change the ratio G''/G' ($\tan \delta$). As it is evidenced by $\tan \delta$ values (Fig. 3), the lowest ratio between G'' and G' , indicating a more elastic dough, was obtained with D. This is in accordance with the increased farinographic stability with respect to control (+20%) as shown in Fig. 1. In the case of KE dough, the incorporation of D led also to the lowest value of $\tan \delta$, indicating a more elastic dough as was observed with BP.

It is expected that differences in the rheological behavior of dough should have a correspondence with the variations observed in the microstructure. For both flours, the most elastic dough, measured by $\tan \delta$, was found in the presence of DATEM. Figure 4 shows the characteristic structure of gluten as visualized by SEM, corresponding to BP and KE dough with and without DATEM. BP dough seems to exhibit a more continuous gluten network, with visible film zones while KE network is more filamentous and disrupted. The addition of D seems to partially disrupt the BP gluten network, while in KE a less filamentous matrix can be observed. Pectin addition did not show clear effects on the structure as seen by SEM (results not shown).

Breadmaking Performance

Desirable quality attributes in bread are a higher specific volume, related to a more spongy and soft crumb, and a low width/height ratio. A higher width/height ratio suggests more spread and flat pieces. This parameter, but in a great proportion specific volume,

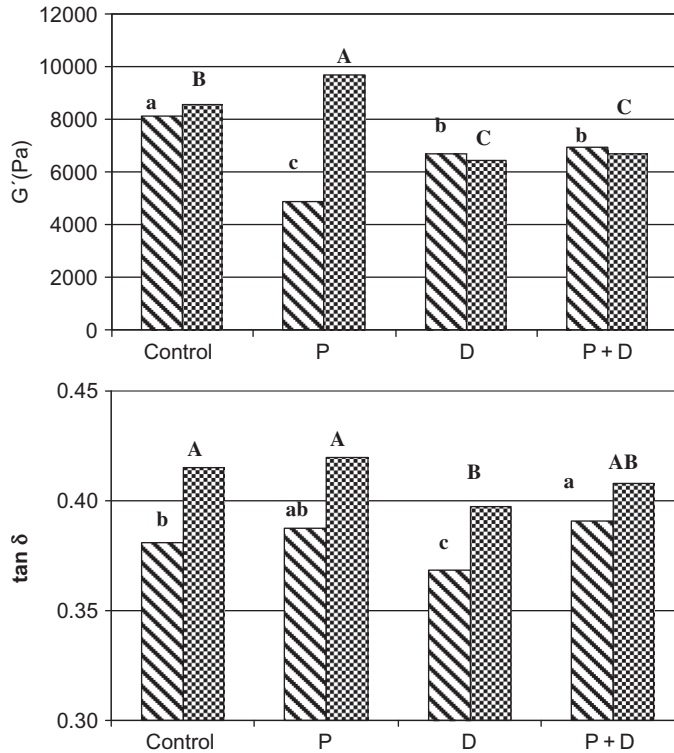


Figure 3 Elastic modulus, G' (0.1 Hz) of different dough: pure flour (C); flour with pectin (P), DATEM (D), or the mix of both additives (P+D). Column codes: scratched, BP; crosshatched, KE. Different letters for the same flour (BP or KE) indicate significant differences between values ($p < 0.05$). Small letters: BP; capital letters: KE.

are indicative of bread quality. BP and KE breads without additives showed a specific volume not significantly different,^[14] but a distinct width/height ratio (Fig. 5). The higher width/height ratio of KE pieces would also indicate an inferior breadmaking performance of this varietal flour.

Specific volume of bread (Fig. 5) increased with additives both for BP and KE flours. Pectin increased this parameter in both flours, in agreement with results obtained by Rosell et al.^[12] with other hydrocolloids. The higher improvement was obtained with the addition of P+D. For BP, additives led to a decrease of width/height, particularly in the case of D and P+D, indicating a positive effect (less flat pieces of bread). In the case of KE, a decrease of width/height ratio was observed only with P.

Differences observed in bread volume are directly related to a different structure of crumb. A crumb with high alveolus diameter and a uniform structure was obtained with BP variety.^[14] Hardness of bread crumbs was also different between both varietal flours (Fig. 5). Unlike the expected, this attribute was higher in BP than in KE crumbs. The effect of incorporation of DATEM was also different for both flours. DATEM increased hardness of the KE crumb, but decreased that of the BP crumb. The addition of P or P+D decreased this parameter for both varietals.

The force that is needed for rupturing the bread crust indicates the degree of crispness, considered also as a desirable attribute in some kind of breadmaking products. BP

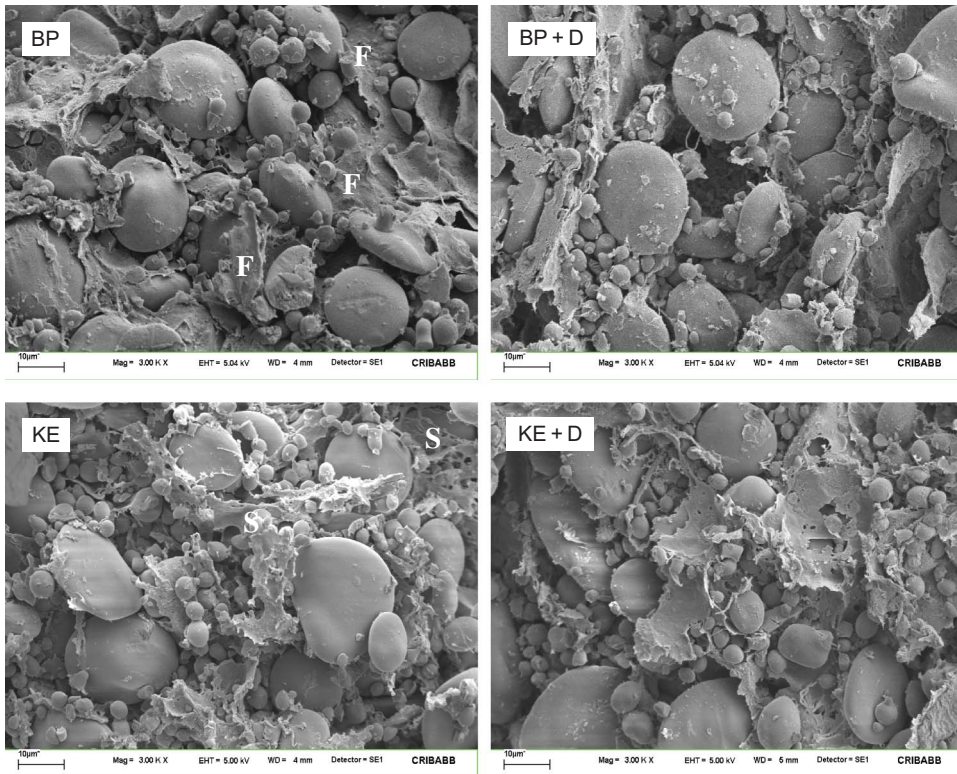


Figure 4 SEM of dough from BP and KE varietal flours without and with HMP, DATEM, and P+D. Bar = 10 μm ; F = film zone; S = gluten strand.

showed higher values of this parameter than KE, and P was the only additive that significantly increased this parameter, mainly in BP. On the other hand, none of the assayed additives markedly modified this attribute in KE breads. The crispness increase observed with P could be related to the hydrophilic behavior of the hydrocolloid that avoided water migration from crumb to crust. On the other hand, DATEM significantly decreased crust texture of BP bread, while it did not change this parameter in KE, probably due to the fact that the emulsifier does not interfere with water absorption.

These results suggest two ways of action. One, different additives should be employed to improve bread characteristics according to the varietal flour used. Second, different association of varietal flours-additives could be used to achieve special characteristics of crust in baked products. DATEM is a surfactant that can interact with flour components like fat, protein, and starch. Anionic residues of DATEM can neutralize the cationic residues of gluten proteins, thus diminishing the net charge and favouring the conglomeration of gluten. This effect of DATEM leads to a stabilized and reinforced gluten structure with the consequent improvement of gas retention.^[22] However, data from the literature shows a controversial effect of this additive on breadmaking. Xiujin et al.^[23] found an improvement in the shape ratio (height/diameter ratio) of Chinese bread added with DATEM but no positive changes in specific volume were found by these authors. Aamodt et al.^[4] found a positive effect of DATEM on the area of the slice and the shape ratio of hearth bread made from strong and very strong flours (HMW-GS: 5+10 type; glu-1 quality

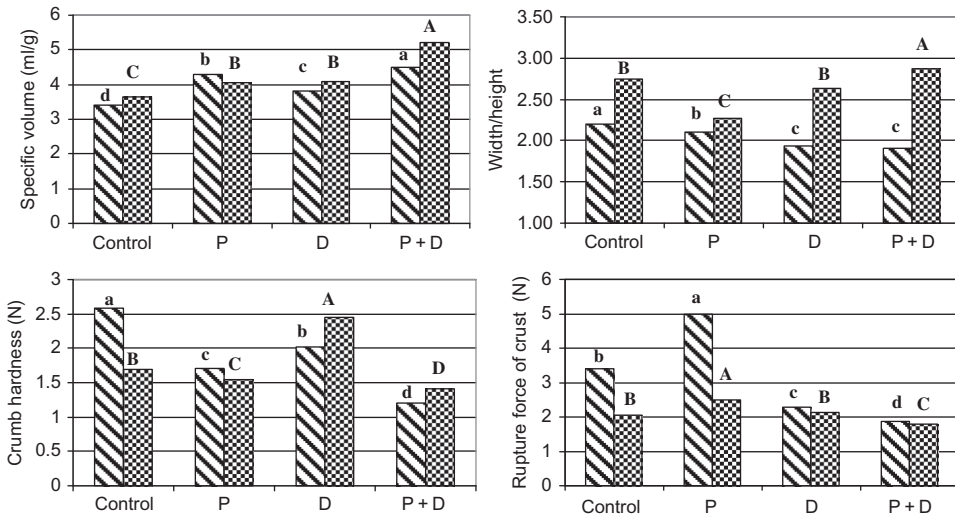


Figure 5 Specific volume, width/height bread relationship, and crumb hardness for different breads: pure flour (C); flour with pectin (P), DATEM (D), or the mix of both additives (P+D). Column codes: scratched, BP; crosshatched, KE. Different letters for the same flour (BP or KE) indicate significant differences between values ($p < 0.05$). Small letters: BP; capital letters: KE.

score: 9). However, these authors did not find the same effect when using less strong varieties (HMW-GS: 2+12 type; glu-1 quality score: 6). Our results confirm that DATEM can have a differential effect according to the type of flour used, and this effect is particularly positive when a strong flour is used. Our results show that in spite of the weakening effect of pectin in dough,^[8] the mixture of this additive with DATEM can have a better effect than DATEM alone, depending on the varietal type.

In conclusion, results from instrumental analysis show that for BP, the global best performance was obtained with the mixture P+D. For KE there is not an additive rendering an improvement in all attributes. However, the mixture P+D could also be employed. The results from sensorial analysis of breads are shown in Tables 1 and 2. These results supported the conclusions drawn from instrumental parameters. For BP, crumb/crust texture, flavour, and overall acceptability were similar to control samples when P+D were added. Pectin decreased the score in all parameters and D negatively modified appearance and crust texture. The high value of rupture force of crust in BP+P (Fig. 5) was not a positive characteristic for the panelists, probably because there were heart buns, so a soft crust texture could be preferred. On the contrary, all additives improved KE consumers' acceptability. All sensory parameters were improved, particularly, with D and P+D.

CONCLUSIONS

The additives assayed in this work (Pectin, DATEM, and a mixture of Pectin + DATEM) showed a differential effect on the performance of dough and bread from varietal flours. In general, additives exhibited a similar trend in alveographic and farinographic assays for both varieties. Though farinographic stability and alveographic W were, in most cases, negatively affected by additives, P/L ratio followed a tendency to greater values in all formulations, which means a positive effect of additives incorporation.

Table 1 Sensorial parameters of BP breads: appearance, flavor, crumb texture, crust texture, and overall acceptability.

	Overall acceptability	Appearance	Flavor	Crumb texture	Crust texture
BP	6.33 ab	7.02 a	6.21 a	6.39 a	6.46 a
BP + P	5.70 b	5.28 c	4.97 b	5.38 b	4.99 b
BP + D	5.91 ab	5.36 c	5.67 ab	6.18 a	5.12 b
BP + (P+D)	6.54 a	6.20 b	6.20 a	6.52 a	6.30 a
MSD	0.77	0.74	0.85	0.78	0.84

Different letters in the same column indicate significant differences ($P < 0.05$).

MSD: Minimum significant differences.

Table 2 Sensorial parameters of KE breads: appearance, flavor, crumb texture, crust texture, and overall acceptability.

	Overall acceptability	Appearance	Flavor	Crumb texture	Crust texture
KE	4.36 c	4.69 b	4.57 c	4.04 c	4.28 b
KE + P	5.76 b	6.90 a	4.68 c	6.24 b	6.18 a
KE + D	6.72 a	6.30 a	6.93 a	6.97 a	6.17 a
KE + (P+D)	6.60 a	6.81 a	5.99 b	6.65 ab	5.62 a
MSD	0.73	0.81	0.89	0.71	0.68

Different letters in the same column indicate significant differences ($P < 0.05$).

MSD: Minimum significant differences.

These changes in the elasticity/extensibility ratio of dough could be related to the formation of a better gluten network, rendering higher volume breads with softer crumbs. Among the alternatives assayed in this work, the mixture of pectin and DATEM showed a global better performance when compared to pure additives. This effect was found in both varieties, the weak (Escudo) and the strong (Buck) ones, but sensory aspects were particularly improved in the case of bread from the weak varietal. This reinforced effect of pectin and DATEM can be related to their different chemical structure (hydrophilic character of pectin and hydrophobic character of DATEM). Thus, this mixture allowed obtaining breads with a better loaf volume, softer crumb, and a good shape ratio, the principal quality attributes of bread.

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