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Use of the RVA™ in the Evaluation of Pasta Processing

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Pasta is a half-product intended for further preparation at home or by food service. In this sense it is similar to other products such as ready-to-eat breakfast cereals and snacks wherein the half-product or pellet is then puffed, flaked or fried. Thus, the ingredient and process effects should be reflected in the half-product qualities. This work was initiated by observations made from RVA analysis of pasta product purchased off the shelf at retail grocery stores. Standard RVA profiles (25ºC-95ºC-25ºC) showed a product profile (Figure 1) reflecting low-cook characteristics with essentially no difference in peak paste between domestic and imported pasta brands. However, application of a critical paste viscosity (Figure 2) showed extremely different profiles and speculation as to the cause — the durum wheat, semolina, extrusion or drying regimen.

This project was initiated to look for the cause of the difference in C-paste RVA. The RVA was used to observe the differences in the ingredients and the effects of extrusion, as well as the effects of the different possible drying regimens. The RVA methods have been previously published (P.J. Whalen, 1998. *Cereal Foods World*, Vol. 43, No.2:69-72).

Figure 1
Standard RVA profiles of domestic and imported pasta brands.

RVA™ PASTA PRODUCTS — STD PROFILE

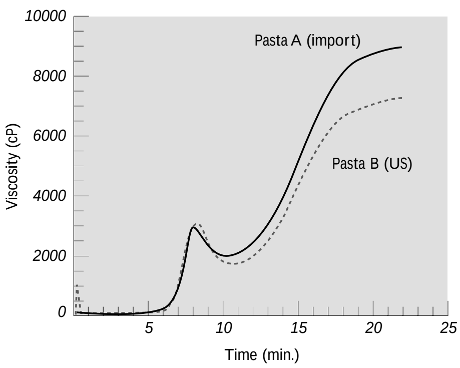
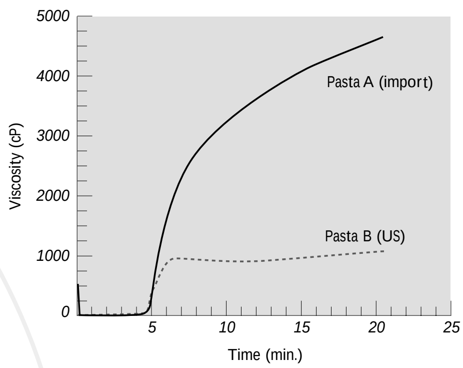


Figure 2
Critical paste RVA profile of imported and domestic pasta (spaghetti).

RVA™ DIFFERENTIATION OF PASTA PRODUCTS



RVA™ Methods

All samples were run on a dry weight basis (dsb), adjusting for moisture.

Standard RVA Profile
Foss Std1 method extended to 15 min.

Idle = 50ºC; mix 10 sec. @ 960 rpm; run at 160 rpm;
Temp. = hold 50ºC, 1.0 min.;
Ramp to 95ºC at 4.42 min.;
Hold 95ºC at 7.12 min.;
Cool at 11 min. to 50ºC;
End at 15 min.

RVA Sweep
Idle = 50ºC; mix at 960 rpm, 10 sec.; run at 160 rpm;
Ramp to 95ºC in 15 min. (End)

Critical Paste RVA
Idle = 25ºC;
Mix at 960 rpm, 10 sec.; run at 160 rpm;
Ramp to 63ºC at 5 min.;
Hold 63ºC, Ending at 15 min.

Wheat

The wheat was purchased for this study through North Dakota State University (NDSU), Fargo, North Dakota, USA. The strong and weak gluten durum wheat was evaluated by RVA. No durum wheat sample was available for the commercial semolina. All moistures were comparable (13.8 - 14%). Mixograph values for the semolina were: strong = 7; commercial = 4; and weak = 1.

Std profile — RVA Data
(in centipoise)

Wheat	Peak	Trough	Setback*
Strong	1002	599	1427
Weak	1535	1026	2323

**Setback as referred to herein is the final viscosity.*

As shown in Figures 3a and 3b below, the strong gluten wheat was differentiated by both the standard RVA profile and the sweep method. The standard profile showed very large differences at all key points of the profile. The weak gluten durum was 50% higher in peak paste, 71% higher at the trough, and had a 63% higher setback.

Figure 3a *Durum wheat RVA profiles of strong and weak gluten durum via sweep profile.*

DURUM WHEAT — SWEEP METHOD, STRONG & WEAK

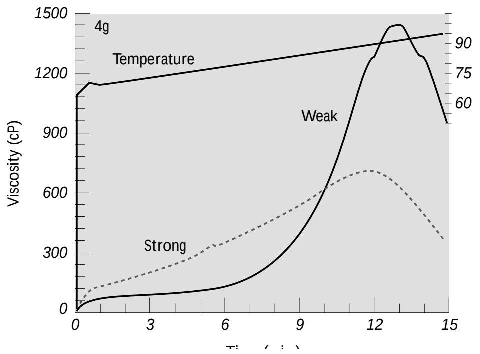
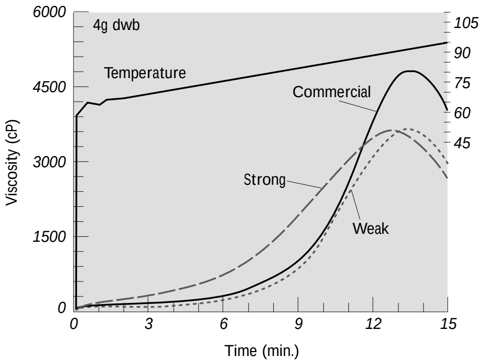


Figure 3b
RVA sweep profiles for the semolina products.

RVA™ SWEEP PROFILES — SEMOLINA: STRONG, WEAK & COMMERCIAL



Dryer Profiles

The profiles used for the low temp. (40ºC, 19 - 20 h), high temp. (72ºC, 12 h) and ultra-high temp. (89ºC, ~7 h) drying were the standard conditions (humidity profile) used at the NDSU Durum/Pasta Lab. Samples were taken exiting the extruder, then just prior to starting the dryer (zero), and at key transitions in accordance with each profile (low = 1 h, 11 h, and final; high = 4 h, 10 h, and final; ultra-high temp. = 1 h and final). Standard RVA profiles were run on all samples and sweep profiles made on the final products to identify a critical paste temperature.

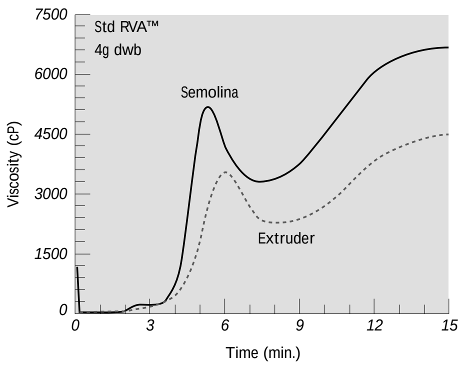
Results

Effects of Extrusion

An extruded product will generally always reflect a degradative RVA profile compared to the starting material. RVA profiles can follow this effect very well since the profile decreases and shifts as the material is changed by mechanical input (Figure 4). This is essentially what happened in the pasta process along with some other significant effects.

Figure 4
Effects of extrusion on strong gluten semolina — initial product transformation.

EXTRUSION EFFECT — STRONG GLUTEN, SEMOLINA vs EXTRUDER



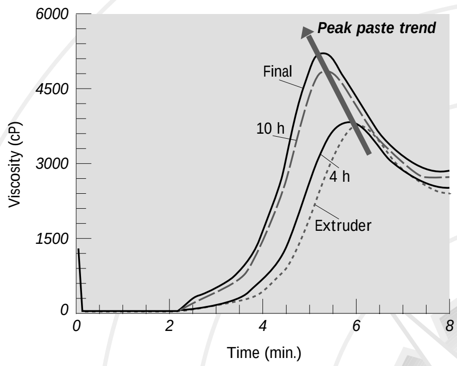
Effect of Drying

The trend during the drying regimen is for the peak paste to shift left as the temperature increases during drying as shown for the high temp. (HT) treatment in Figure 5. This is evident in the ultra-high temp. (UHT) drying profile as well. Although only one sample could be taken after starting the dryer, it is evident that the initial shift is quite dramatic. Also, the UHT setback was always higher in the final pasta product for all semolina varieties. This further indicates cross-linking and similar reactions as seen in thermally pre-conditioned materials. These may or may not be associated with protein interactions. It is assumed and accepted as general knowledge that the high relative humidity aids in the conductive heat transfer and assists in the drying effect as in other half-product treatments. Figure 5 shows the UHT profiles for the strong gluten. The commercial source behaved very similar to the strong gluten.

The C-paste method confirms and verifies that the differences observed in the off-the-shelf samples of pasta are due to the different drying profiles employed — low temp. vs ultra-high temp. In Figures 6 and 7, the pattern shown for the different sources of durum semolina by the C-paste method indicate that the material is continuing to cook in the dryer at the UHT temperatures. This is why the absorption changes are so radical and are so easily detected by RVA C-paste for UHT pasta. UHT drying definitely continues the gelation of starch and this in turn would promote an interaction/network with any protein complex. The fact that the material retrogrades so readily is also indicative of the structure being formed in extrusion and drying. That Pollini (Pasta and Noodle Technol., AACC, 1996) notes a broader performance capability and tolerance for poorer grades of semolina by this method of drying is indicative of the interplay between starch cooking in the dryer and the extrusion forming process.

Figure 5
Trend in peak paste shift at high temp. drying regimen for strong gluten pasta.

TREND IN PEAK PASTE — STD RVA™, STRONG GLUTEN, HT



A comparison of the general effects of the drying regimen is shown in Figures 6 and 7. UHT showed the highest paste viscosity followed by the high temp., and the lowest being the low temp. profile. These differences are directly related to the drying conditions (especially temperature) and the structure set-up in the pasta by the dryer. This trend was found to be the same for all three semolinas with varying degrees of differences among semolinas.

Figure 6
Critical paste profile for the strong gluten semolina (63ºC profile).

CRITICAL PASTE RVA™ — STRONG GLUTEN PASTA

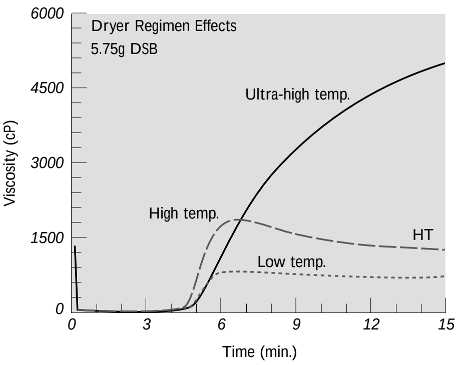
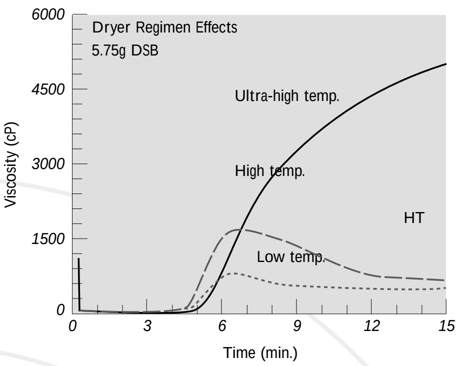


Figure 7
Critical paste profile for the weak gluten and commercial semolina (63ºC).

CRITICAL PASTE RVA™ — WEAK GLUTEN PASTA



Conclusions

Durum Wheat
Differences between the durum (strong and weak gluten) are very apparent via Std RVA.

Semolina
Differences are apparent via both the standard RVA and the RVA sweep profile.

Pasta
Extruder — standard RVA showed differences between semolinas;
Dryer — differences were found between semolinas and dryer profiles;
Final Product — differences were strongly differentiated via dryer temperature profile (low, high, UHT) using the critical paste RVA and by semolina type.

This work also points to mechanisms occurring in the pasta process that are important and include the different responses of the strong and weak gluten and the totally different response of the commercial grade semolina. There is no doubt about protein quality as a factor but the interaction and effect of starch is also important. The very reason the UHT does what Pollini indicates with lower quality semolina is starch based. It is entirely likely that there is an interactive mechanism at work but the UHT is driven by starch gelation in the dryer as a cook effect. Translation to sensory and other product quality factors needs to be shown. However, both the extruder and dryer are driving factors for manipulating sensory responses along with semolina quality. In this work, we have only taken the 'known' and monitored it. The real opportunity is to take what was uncovered and apply this information in a knowledgeable manner.

TIPS & TRICKS

Exporting Experiment Data

A question which is frequently asked is how to send data, results and graphs from our Thermocline for Windows (TCW) software to other Windows programs such as MS Excel or Word. Using TCW version 2.0 or later, this is easily achieved:

First, run TCW and press F9 to cross to the Collection Tool. Now go to the Options menu and check the option to 'Save Data Comma Delimited'.

TCW will now save two data files for every test that you run. The first is the normal dat file (e.g. mydata.dat) for display in TCW's Analysis Tool. The second is a text copy of your data with the extension csv (e.g. mydata.csv), in Comma Separated Variable format.

The csv file contains date, instrument, calibration and profile information, and the test data arranged in four columns under the heading 'Datapoints'. The data columns are time in seconds, viscosity in cP, temperature in 0.05ºC increments and speed in RPM.

The csv file can be imported into other Windows programs.

For example, to load it into Excel 97, select File – Open – Files of type: Text Files – and enter the file name.

If you have already created TCW data files without corresponding csv files, you can create text files from these later by using the datatext.exe utility located in your TCW directory.

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