BAKER'S PROCESS GUIDE

Why Your Flour Quality Control Sometimes Fails, and How to Fix It

Baking Industry Observations Often Overlooked

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Wheat is Unique, and So is Your Process

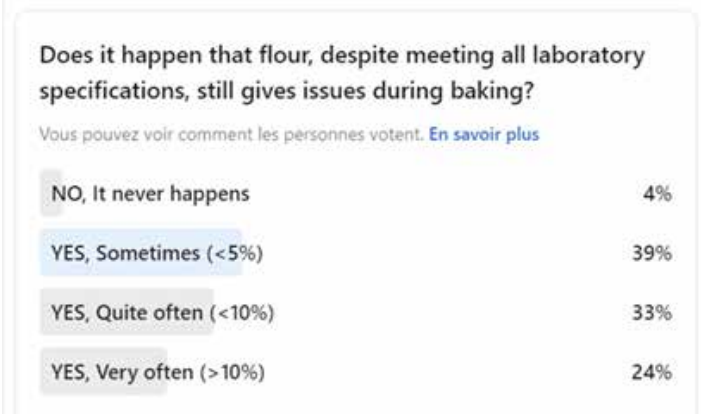
Baking is a fascinating industry. It is a mix of traditions, cultures, and never-ending innovations. When we say "baking," we refer to many different cereal-based end products such as biscuits, crackers, cookies, leavened breads, pastries, steamed breads, flat breads, noodles, pizzas, donuts, pretzels, etc. For a similar product, the recipe and the process can be significantly different from country to country, from bakery to bakery, and even from baker to baker.

The only common denominator between all these end products is wheat flour. "Wheat is unique," we often read. Wheat flour indeed provides the necessary properties enabling a baker to produce dough, shape it, and finally bake, steam, freeze, or fry it.

It makes sense then that the wheat-flour-bread chain operator strives to identify what defines a "good" flour. There is no such thing as "good" or "bad" flour. By adapting his techniques to flour properties, **Pr. Calvel** made a good loaf of bread from almost any type of flour. He clearly demonstrated that the finished product results in the combination of flour characteristics and specific baking processes. So, instead of "good" and "bad," operators can shift their thinking and benefit from speaking about "process-adapted" or "non-process-adapted" flours.

By establishing this new principle, the challenge is "How do bakers define a process-adapted flour?" There are plenty of analytical tools at the baker's disposal, offering what they want to know about wheat flour's deepest secrets, and we are conducting all sorts of baking tests. But is the situation under control?

ARE CERTIFICATES OF ACCEPTANCE (COA) TELLING THE COMPLETE STORY ON FLOUR QUALITY?



When KPM Analytics meets with bakers, the conversation usually begins around their flour quality control (QC) system and whether it provides the complete information they need to control their process and final product consistency. We also recently conducted a LinkedIn survey, and results showed that **96% of industrial bakeries indicated that despite a COA, they still experience quality issues online.**

For a fourth of the interviewed persons, these **issues happened in more than 1 out of 10 deliveries.**

Interestingly, the 4% of replies stating this never happens were in academia, not replies from bakers who work with production lines daily. This consequence illustrates a gap between theory and reality, telling us that despite all attention brought in building COAs, issues still exist online and/or on the finished product. And this can be costly for bakers, both financially and potentially in terms of image.

If a QC manager has determined that issues are still occurring despite COA approval, the next questions are: **"Who decided to put these values on the COA and why?"** From an external standpoint, many assume that each value mentioned in the COA really matters and that the indicated tolerances link to good performance. The reality is that most of the time, this is not true. KPM Analytics recently had a wafer producer tell us, "Even if the flour is within the acceptance range, sometimes it works, and sometimes it does not. I do not know what to do." In this case, all indications on the COA were about protein and gluten behaviors. There were no mentions of starch properties. Most of the time, the miller proposed the specifications because they have the most experience with flour.

It is also essential to consider how bakers evaluate flour quality when it is received. Too often, flour quality evaluation compares the miller's data with the COA without testing. By doing this, the baker takes on all the risks. Considering new control methods versus following an existing process may be the key to better outcomes.

The miller is a serious professional, and sending non-conforming flours is not done intentionally. But errors can happen, such as shipment errors or analytical inaccuracies, for example. With better COA control, bakers can avoid discovering issues online. In the case of analytical testing and using a curve (such as from an Alveograph, Mixolab, Farinograph, Extensograph, etc.), QC managers must see the curve because the same data can be obtained with different overall behavior.

Trust does not exclude control, and bakers can take a more proactive role in analyzing their critical raw materials. Sending samples to third-party labs remains an option. Still, often, the flour lot will have been processed by the time results return, which only provides a postmortem explanation about conformance.

WHAT FLOUR PARAMETER IS MOST COMMON IN COAS?

Protein content! Protein is an essential piece of the puzzle; it is convenient and easy to measure precisely. However, most users agree that we should focus less on protein content. Why?

Because protein quantity does not reflect protein quality **(Figure 1)**. Protein became popular with the development of Near Infrared Spectroscopy (NIR) and Near Infrared Transmission (NIT) technologies. Before, this protein content needed complicated chemical system measurement based on the Kjeldahl method, and very few millers conducted these tests. Originally, gluten was extracted manually, which means not only looking at the quantity but also at the quality. Many bakers learn how to evaluate the characteristics of hand-extracted gluten. Most of this "expertise" has been replaced by numbers. However, numbers do not explain everything.

Over the last years, we have seen an increased use of flour analytical tools. The most famous being the Alveograph and the Farinograph. Most of the COAs in the world include parameters of one or both units. With these instruments, there are essential factors that need consideration.

These tools were invented 100 years ago to give millers a way to understand their white (straight-grade) flour. The aim was to ensure delivery consistency for the baker, leaving them with less adaptation work. When this started, industrial bakeries were much smaller and manually operated. Furthermore, master bakers adapted the process to face any unexpected flour variation (without enzymes or additives). The master bakers could do this so that it was enough for the miller to have a rough understanding of the flour type required to ensure consistency, knowing that the bakers still had the expertise and technical possibilities to "adjust."

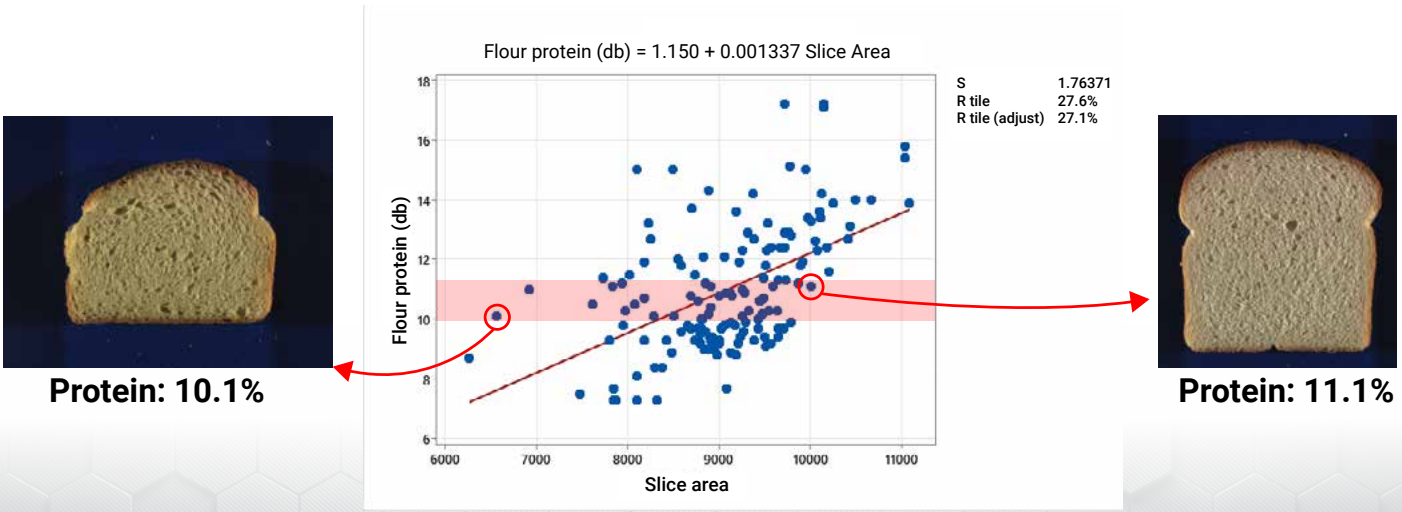


Figure 1: Bakers of sandwich breads will typically request flour that has flour protein ranges between 10% and 11.5%. However, as this study shared, flours with similar quantities of protein yielded very different final products.

As Bakeries Evolve, Methods for Assessing Quality Should Also Evolve

Over the last 50 years, the bakery world has experienced an outstanding – and accelerating – revolution.

The most obvious observation is that the production plants are getting bigger. What used to be considered industrial bakeries in years past now appear more like large craft bakeries by today's standards. The number of pieces produced today is reaching vertiginous numbers.

The processes have evolved outstandingly over the last 20 years. Products that were supposed to be only shapeable by hand (like pointed-end baguettes, very soft Ciabatta doughs, or pretzels) are now produced on high throughput industrial processes using sophisticated automated machines.

This shift towards more industrial production is a significant game changer. Nevertheless, the way of looking at flour quality has mostly stayed the same over the last century. Bakers and millers keep using the same old strategies: hard wheat makes strong flour good for bread, or soft wheat makes weak flour good for biscuits. Of course, this works as a rough approach, and it was certainly sufficient when bakers could give the necessary adjustments to process the flour's variation. But this approach finds its limits with high throughput, strongly automated plants where the results of non-process-adapted flours can create considerable issues and impact bakery performances and bottom line.

This evolution created a situation where the need to understand better the flour's properties became an emergency. Researchers have been beneficial in identifying and understanding the many constituents of flour. They created laboratory-based or lab-baking scale models to explain how the flour mixture influences volume, color, stickiness, etc. At the same time, there was an outstanding development of improvers and enzymes aiming to "correct" flour weaknesses.

Today, bakers still regularly witness or read experts telling them what good flour for certain products should look like. These experts tell bakers that "good flour" should have "water absorption around this value" or "dough strength needs to be between these values." If there is one thing we have learned dealing with the industry over the last 30 years, it is that this approach needs to be revised.

KPM Analytics is contacted daily by bakers showing us analytical curves or sending us a flour sample and asking us to tell them if this is good for them or how to improve. We cannot seriously answer these questions. Other vendors face the same issue simply because the baker's production specificities and specific problems are unknown to a supplier. The only way experts can answer these questions is to refer to global-shared knowledge. This shared knowledge may provide the baker with the correct general direction but needs to be more precise to solve issues and to improve their specific situations.

Because bakeries do not know the answers, they try to scan all possibilities, sometimes getting into very complicated rheological concepts. Bakers may also feel they need to be highly skilled experts to deal with flour quality. As a matter of fact, when it comes to flour, bakers mostly rely on others' advice because they feel it is a highly complex subject. Many bakers tell us they are not flour experts, hoping external people or suppliers will give them ready-to-use data to put in their COAs. Operating in this manner creates very frustrating situations for everyone.

COMMUNICATION GAPS BETWEEN QC TEAMS AND PRODUCTION OPERATIONS

Finally, **there is a need to create more communication between the QC team controlling flour specifications and the production operations.** On the QC side, if the flour arrives at the bakery within the COA limits, it must be accepted. And if it does not perform properly, it is certainly something else than flour quality. On the production side, they receive flours accepted by QC yet struggle to have flour perform correctly online (remember, 96% of surveyed bakers experience issues despite COA conformity). This conflict drives them to believe that COAs are useless. Luckily, because they are baker experts, they can still save the day, adjust the process, and make the best with this problematic flour. This non-communication has been observed in many plants worldwide, including huge companies, and is one of the main drivers for frustrating COAs and, indeed, a place where improvements can benefit the bakery.

In these changing times, more and more bakers mention that the critical **master baker's experience is gradually disappearing for the production lines.** Most bakers KPM has visited comment that their baking experts, the ones who they rely on to adjust the process when things go wrong, are near retirement. Others decided to try different career paths, and this trend accelerated during and after the COVID-19 pandemic. New managers are now seeking to capitalize on this important and company-specific know-how. It takes time to train real baking experts, and many industries are still determining if such expertise will be possible to develop again, so they try to at least maintain an existing one.

This issue is even more sensitive because the baking industry faces many new challenges today. First, trends toward customers' new requests, such as whole wheat, gluten-free, plant-based protein, and even Keto diet, are rising. Economically, with the increasing price of raw material and energy costs and limited consumer capacity to spend more, producing in the most optimized financial conditions becomes critical. Avoiding production issues and product losses is a good start.

For industrial bakers who have experienced any of the difficulties mentioned above and are seeking new methods to control flour quality control, there is good news: **Solutions to many of these production issues exist!**

Unique Challenges Today's Bakeries Face

Master Bakers are Gradually Disappearing from Production Lines

New Consumer Demands (Whole Wheat, Keto, Gluten-Free, etc.)

Rising Costs (Ingredients, Energy, etc.)

How to Adapt Your Flour Quality Control in a New – More Competitive – Environment

STEP 1: ANALYZE THE EXISTING SITUATION

First, **bakers must become a leader in flour specification.** Bakeries produce goods; they know their processes and recipes better than anyone, but they also directly suffer (and pay for) when things are not working as expected. The more the flour is a key element of the baker's process, the less they can let others decide what is good for them. In extreme cases, flour is not process-adapted, but to make the flour more tolerant, bakers add improvers as a safety. This action works to some extent, but there is a more direct and economical way. We have witnessed cases in South America where enzyme use took priority over flour quality control, which is not always economically beneficial to the bakery.

Once the baker has decided to take control, the second step will be to **look at what they are currently doing.** QC and production managers in baking plants should always ask themselves three simple questions:

1. Do we have product losses or quality issues we would like to reduce?
2. What is included in our COA?
3. Who decided the COA parameters and limits…and why?

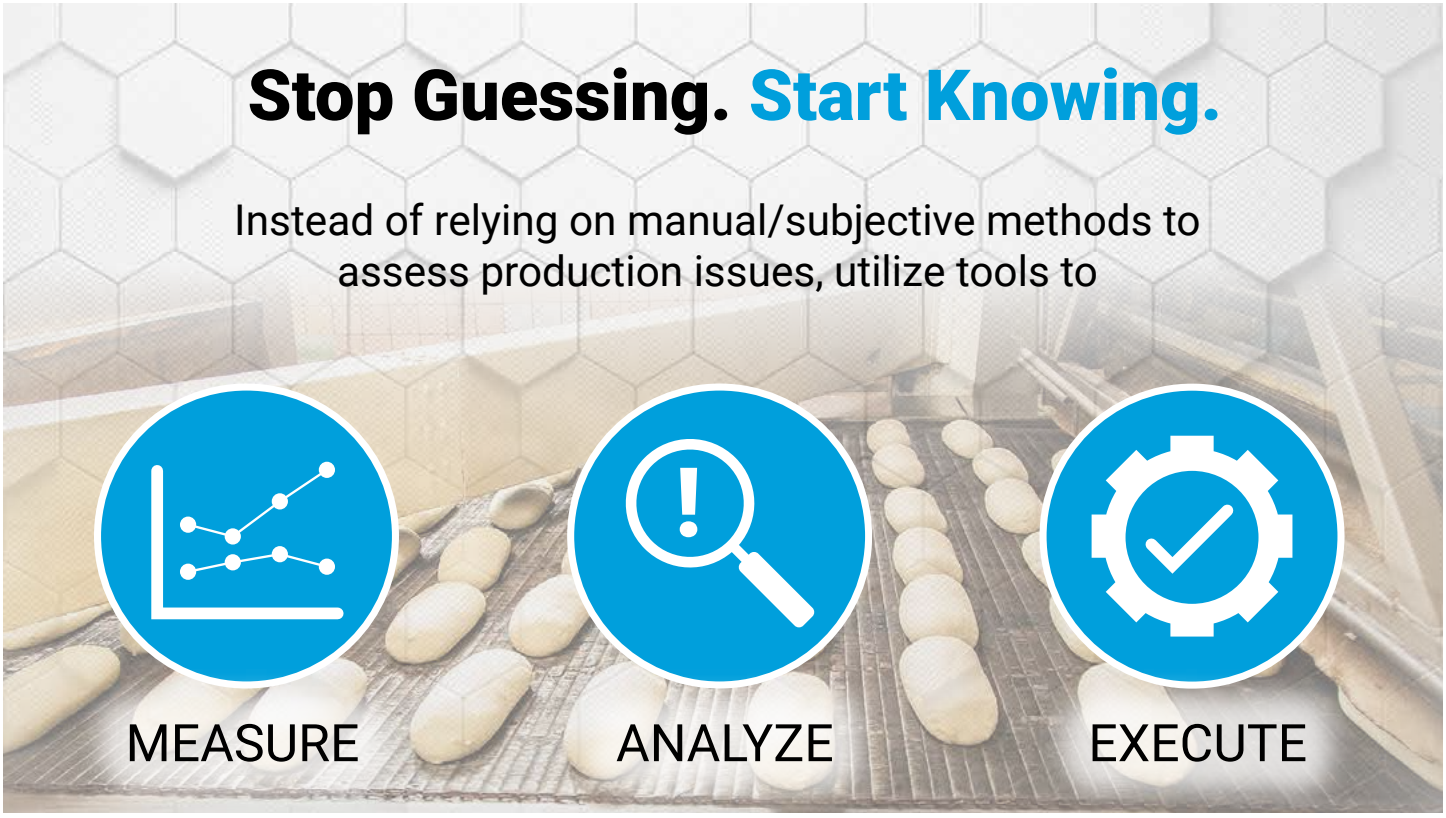
Let's go back to our 96% of interviewed bakers: If they still have production issues despite COA being duly established and controlled, it does not necessarily mean their processes are wrong, but it could mean they need more information to control consistency.

Nobel-prize winner Albert Einstein is attributed to saying, "The true definition of madness is repeating the same action over and over, hoping for a different result." If COAs do not prevent bakers from flour-related issues, they must think out of the box and be ready for innovation. Too many times, when presenting a new analytical solution, the main question we receive is, "How does this relate to [previous tools]?" We have seen laboratories using new innovative technologies but reducing them to get results closer to older, existing tools. Let's ponder this: If an existing tool allows a baker to have complete control of the flour quality and avoid all production issues, then why wouldn't he use this very tool? Now, if an existing device fails to prevent bakers from having product losses, using a new tool to predict results from this existing tool from another potentially more powerful tool makes absolutely no sense. We understand bakers have historical data they want to continue to follow, but if this history does not help the plant be more efficient, it may be time to try something new.

At this stage, **we must consider that each production process is unique** and that **only bakers know what works for them.** Each line is unique; for example, we faced many situations where two side-by-side production lines delivered different end products. The solution is to keep it simple, focus on the product or production line causing the most trouble, and work forward.

The next and probably most crucial step is to accept switching from expert guessing to data-driven measurement. The objective here is not to replace but to help translate baking expertise into measurable numbers."Master bakers are, and will continue, doing outstanding work keeping plants up and running. But first, they are not present on site 24/7, and second, they are less and less easy to find. Learning from the process with the support of master bakers, helping them put numbers on their "dough feeling," is probably the best strategy to ensure the company's future.

When bakers have reached this point, they are ready to enter a new and improved flour QC concept.



STEP 2: CLEARLY DEFINE THE OBJECTIVE

For bakers to define what is suitable, it's important to view things backward - from finished product to flour. We previously mentioned that the former QC model, aimed at predicting the suitability of flour to process just by looking at analytical data, is insufficient. The proposal is to integrate the plant's uniqueness **by learning what works for a specific process.** Instead of relying on manual processes or certain levels of expertise, the proposal is to measure, analyze, and execute.

It all starts by looking at the end.

The purpose of a baking plant is not to produce baked products. **The purpose of a baking plant is to create baked products that meet consumer's expectations.** The bakers know better than anyone else the characteristics (shape, volume, crunchiness, color, taste, etc.) that make their products unique and appealing to customers.

Let's take the example of a product whose fundamental characteristics are size and color. How does the company ensure no flat or off-colored product reaches supermarket shelves? In most cases, we observe operators removing the non-conformed products. Visiting a production plant, we asked the manager, "How do these employees know which product to leave or to remove?" He showed us a poster guideline with advice to operators. Looking at the trash bin, we noticed many products did not look like the guidelines. He said, "Yes, I know. We try to have all operators doing the same, but it is complicated depending on the person, and sometimes, for the same person, it can fluctuate from day to day."

Besides the evident impact that rejection has on the company's bottom line, this situation is a significant indicator to implement an efficient QC system because:

- For the same flour, the rejection rate can vary from one operator to another, from one day to another.
- We do not know what caused the rejection. It makes a big difference if the product is rejected because of a volume issue or because it is too dark.

If bakers cannot precisely measure if their end products do not reach the quality target or quantify the reasons for rejection, there is no way of understanding what process-adapted (or non-process-adapted) flour is. This approach considerably reduces the chance to set up new and adapted COAs.

The final product rejection rate is a bit of a taboo in plants. It is often called "feeding the pigs" because if a product does not meet standards after baking, bakers can do little to limit these losses. Interestingly, many companies tend to minimize the

situation, but we have witnessed tortilla-making companies experiencing up to more than 15-20% rejection rate, with losses counting in millions of USD. Yet, all these companies have installed flour specifications with COAs but are still using the old ways.

One thing to consider is improving the understanding of how the line performs by replacing manual removal with objective measurement. Today, vision systems offer many benefits to the companies using them. Not only do bakers clearly understand how the process is performing by measuring an objective (and adjustable) rejection rate, but they also learn more about the reasons that caused this product rejection. In terms of establishing optimized COAs, it makes a big difference knowing if most of the products were rejected because:

- Their volume was too big (flour/process)
- They were missing sesame seeds on the topping (process)

Bakers should diligently pursue these answers, and the more information bakers can get from the process, the better their capacity to improve it. What you can measure, you can improve!

STEP 3: DEEPER LEARNING OF YOUR PROCESS

Now that bakers can measure their process performance objectively and precisely, they might want to understand more about their process.

The state of the dough just before the final transformation (baking, frying, steaming, freezing, etc.) is critical. Bakers should ask, **"How do we ensure the dough has the required characteristics?"** Most of the time, it relies on expert assessment, primarily by touching the dough. As bakers' expertise is gradually disappearing from the plant, more companies are implementing analytical tools used at-line, helping operators maintain production consistency, even if they are not experts. The benefit of analyzing production dough is that we are as close as possible to the actual processing conditions (recipe, mixing, etc.), so the link between dough observation and final product characteristics is stronger.

Let's go back to the final product assessment. An objective vision inspection system is key to improving flour QC and **developing COAs that suit specific bakers' needs.**

By knowing the outcome of using a specific flour lot, the baker can decide whether it is process-adapted or non-process-adapted flour. At this stage, bakers are not depending on other's advice, nor do they need strong scientific knowledge; **they are directly learning from the process of what works for them.**

This learning phase is critical but very easy to do; it only requires:

- Objective final product (and/or dough) measurements
- Communication between Production and QC teams
- Willingness to think outside of the box and evaluate new testing possibilities.

The last point is crucial because it would make no sense to try this with existing tools already proven to have limitations. From our previous 15 years of experience, we have often seen that the missing part of most flour QC is the starch contribution to final product characteristics. Remember that current tools and protocols to analyze white wheat flour are over 100 years old and focus heavily on analyzing protein behavior.

We need to realize that 70% of the flour we use is composed of starch. And that starch is very functional. Mixolab, a universal dough characterizer, has helped provide more comprehensive information on protein, starch, improvers, enzymes, and all interactions between them. Used as an at-line instrument, Mixolab has allowed the baking industry to quantify their product results with their flour's rheological properties, thereby supporting their process adjustments.

Mixolab 300 Universal Dough Characterizer

When Bakers Command Their COAs, Everyone Benefits

By establishing the link between objective information on the finished product and accurate data characterizing process-adapted flours, **bakers can write COAs based on what is good for them.** If different tools are included during the exploration phase, we can identify the ones helping bakers obtain the control parameters that really matter in their COAs. To such an extent, the next time someone asks, "Who wrote your COA?" The answer will be, "We did, based on the observations of what is good for us." If the baker manufactures different products, they can repeat the same pattern and create COAs that are truly adapted to each flour's needs.

These new COAs are also helping communicate better with millers. Nothing is more frustrating for a miller than sending a flour fitting the baker's COA yet receiving complaints because the flour was not performing as expected. If we accept the limitations of the current COA based on common knowledge, we can easily foresee the advantage of receiving COAs based on what has been proven to work well for the baker.

Bakers are correct; millers are the flour experts. Millers know precisely how to select, prepare, and blend the wheat to obtain the best flour possible. They also know how to use improvers to fine-tune the quality. However, the problem is that they might not target the correct parameters today.

COAs focusing on protein, water absorption, dough mixing time, and stability do not cover starch. However, starch is 70% of what makes flour. Now, if during the conception phase of the adapted COA, the bakers take care to include devices that give them a complete vision of the many aspects of flour, they are in a better position to tell millers what the critical ones are and, even more, to give them clear targets to reach. Instead of adjusting a mixing time that may not be so impacting, the miller would rather spend more time working on starch behavior if this has been shown to affect final product properties.

SELECTING A DEPENDABLE SOLUTIONS PARTNER IS A CRITICAL STEP IN THE PROCESS

Should bakers decide to move in this direction, choosing a good business partner is critical. They need to find a company capable and willing to listen to them, understand bakers' needs, and help them set up an adapted solution. **Bakers should be very suspicious when presented with a ready-to-use solution.** Remember that what worked somewhere can fail elsewhere. Just because a specific analytical solution is widely used in the industry does not mean it is the best suited for every baker, and it is not because it looks scientifically complex that it will be more efficient.

Bakers need a partner with experience in this field and a profound understanding of analytical tools and possibilities to adapt them to specific needs. Service is also vital to ensuring the solution will work well long after installation. As wheat changes, we might need application support to adjust settings to a new crop, and only industry-leading companies can bring this level of service.

A Solution for Nearly Every Baking Quality Control Challenge

Type of Analysis	Compositional	Rheological	Functional
Parameters Measured	Protein, ash content, damaged starch, etc. of raw flour.	Gluten, protein, starch, dough properties, and proofing behavior.	Damaged starch.
Insights & Benefits	• Verify flour specifications • Make informed production adjustments	• Develop reliable quality control metrics • Align flour quality with production results	• Verify conformity of flours from the compositional and rheological analysis • Close the loop on quality control
Solutions from KPM Analytics	• SpectraStar™ XT Series NIR Analyzers	• Alveograph® Test Series • Mixolab Universal Dough Characterizer • Rheo F4 Dough Proofing Analyzer	• SDmatic 2 Starch Damage Analyzer

More Data-Rich Innovations are On the Horizon

Now, imagine the future. Artificial intelligence (AI) is no longer a dream; it is today's reality. The food for AI is DATA; the more data, the more we can benefit from AI potential. Let's apply this to our bakeries. For many plants, intelligence and knowledge are shared between a few individuals. And this expertise is disappearing daily from the industry. Now, let's imagine the potential of a solution combining information on the raw material (flour and others), the process conditions, the dough properties (dough testing at line), and precise information on final product quality. Combining all this data and using it makes improving process management and creating optimum COAs easier. This path is certainly where the industry is going, which is an exciting evolution.

When times are changing, we all react differently. But these times are increasingly challenging, and companies must be more efficient. There will be a premium to achieve optimal efficiency. We cannot expect to replicate what was done elsewhere and apply it directly the same way everywhere else; adaptation must be done locally. **The good news is that complete solutions already exist.**

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Arnaud holds a Master in Sciences and Techniques for the agro food industry and a Master in International Marketing and Strategy. His original background comes from Biochemistry and he also holds a miller's degree from the French Milling School (ENSMIC).

He started working for CHOPIN Technologies, a KPM Analytics brand, in 1989. His various occupations in the company (he started as an after sales technician) puts him in constant contact with flour producers or users worldwide.

Arnaud is a standardization expert for AFNOR, ISO and CEN. He is active with the BIPEA, corporate member representative for ICC and is also actively involved in Cereals and Grains standardization working groups.

Let's begin the conversation to help you develop a new strategy to reduce waste, save costs, and improve production efficiency. Contact us today at sales@kpmanalytics.com.

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