Mash, scald or cold soak?

MICHAEL MEISSNER, RESPONSIBLE FOR THE DIVISION BAKERY TECHNOLOGY AT THE ARBEITSGEMEINSCHAFT GETREIDEFORSCHUNG E.V. (AGF, ASSOCIATION OF CEREAL RESEARCH), DETMOLD, GERMANY, HAS STUDIED THE EFFECT OF PRELIMINARY STAGES ON THE BAKED GOODS PROPERTIES AND FRESHNESS RETENTION OF WHOLEGRAIN RYE BREAD

+ The properties of milled bread cereal products have changed in recent decades. Milled rye products in particular show lower enzyme activities, which are reflected in higher falling numbers and increased gelatinization maxima and temperatures in the amylogram. Baked goods manufactured in such a way have reduced leavening and thus a lower volume yield than breads baked using milled cereal products with greater enzymatic activity. If the changed rye qualities are not addressed during dough preparation, another result is a dryer crumb with deficient freshness retention properties (shelf life). It is not possible to compensate fully for these deficiencies even by using pregelatinized flours.

Raw materials
Wholegrain rye breads manufactured from two different batches of rye were studied. The rye grains were comminuted to yield coarse wholegrain rye meal, medium wholegrain rye meal and wholegrain rye flour. Flour type 1150 milled from the respective cereals would have falling numbers of approx. 110–180 sec due to the loss of the enzymatically active surface layers.

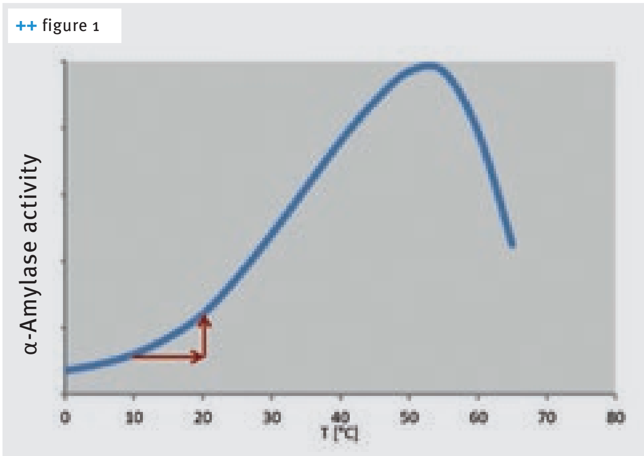
Table 1: Selected characteristic properties of the wholegrain rye flours

	A	B
Moisture	13.6%	13.4%
Meal falling number	98 sec	150 sec
Amylogram		
Max. gelatinization temperature	65.0 °C	67.9 °C
Gelatinization maximum	382 AE	721 AE

source: AGF

(AE = Amylogram Units)

Enzymology
In preliminary stages, swelling processes of the mainly coarse cereal components contribute by physical means to improving the quality of the bread. Cold soaks (swelling), scalds (hot) or mashes (boiling) are starter batches of milled products and/or other raw materials with water but without the intentional addition of microorganisms. Thus the enzymology consists only of the cereal's own enzymes.
The main factors influencing enzyme activity are:
+ substrate concentration (e.g. for the amylases the cereal's starch content),
+ temperature
+ pH value



++ **figure 1**
α-Amylase activity at particular temperatures

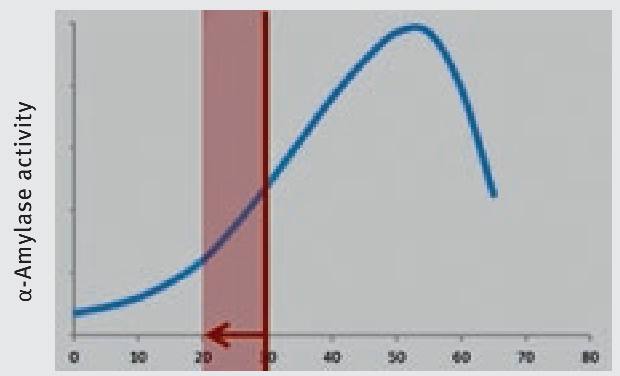
Temperature has the largest influence on enzyme activity. Two effects are observable here:
+ The RRT rule (Reaction Rate – Temperature rule) says: increasing the temperature by 10 °C increases the reaction rate to between two and three-fold. This is due to the fact that greater molecular movement occurs as the temperature rises, and the enzyme reaches the substrate more quickly.
+ Heat denaturing: enzymes are proteins that denature at approx. 40 °C and above. This involves loss of the original three-dimensional shape, and the substrate no longer fits the enzyme's altered binding centre (key-lock principle).

Cold soak
Cold soaks are used in (artisan) practice for rational reasons. They are prepared on the day before dough production and stand at room temperature overnight. No starch gelatinization takes place during this period. Cold soaks are starter batches that are processed cold, mainly with a dough yield of 200, i.e. equal parts of raw materials and water, whole cereal grains, meals and whole oilseeds. The amount added to the dough is relatively large, about 20–40 %, and the necessary

Author
Michael Meissner
Association of Cereal Research
(Arbeitsgemeinschaft Getreideforschung e.V., AGF)
Schützenberg 10, 32756 Detmold, Germany
Tel.: +49 5231 61664-0
Email: info@agf-detmold.de
Internet: www.agfdt.de +++

standing times of at least 8 h are relatively long. Starter batch temperatures are in the range below 30 °C. To avoid spontaneous fermentation, which impairs the flavor and aroma qualities of the bread, it is advisable to add the entire amount of salt in the recipe directly into the cold soak. Another alternative is to reduce the pH by using organic acids or dough acidifying agents.

++ figure 2

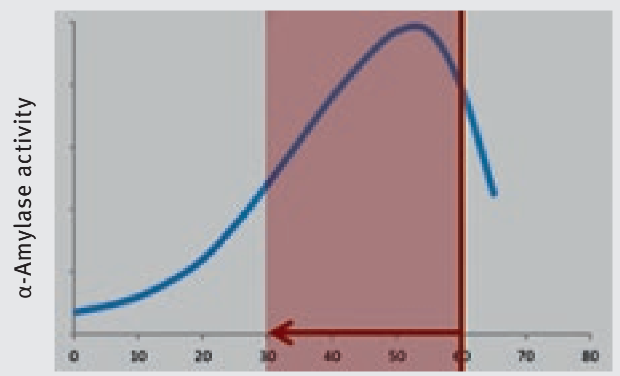


++ figure 2
α-Amylase activity in a cold soak

Scald

Scalds are made with hot water and again with dough yields mainly of 200, leading to a temperature of approx. 60 °C. This results from the temperature of the added water together with the temperatures of the raw materials and equipment. A cold starter batch is also often heated up by passing steam into it. The temperature drops down to room temperature during the standing time.

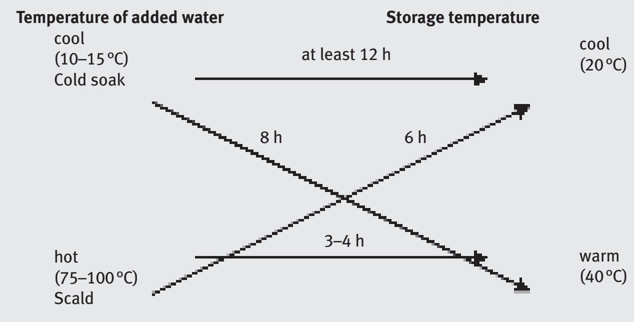
++ figure 3



++ figure 3
α-Amylase activity in a scald

The amount added to the dough, 20–40 %, is large. In this respect there is a close relationship between temperature and standing time. The higher the starter batch temperature, the shorter the standing time can be. However, it should not be less than 3 h. If scalds are allowed to mature for too long or overdosed, this can result in impairment of the crumb elasticity as well of the cuttability and cohesion of the bread crumb due to the larger amount of added water. This also leads to agglomeration when chewed, although it gives a false impression of a prolonged freshness effect due to the high softness and succulence of the chewing sensation.

++ figure 4



++ figure 4
Alternative temperature control schemes for cold soaks and scalds (after Brümmer)

The use of scalds rather than cold soaks is preferable for enzyme-deficient raw materials. Part of the starch gelatinizes at initial temperatures above 60 °C and can be degraded to soluble substances by the flour's own enzymes. As it cools down, the scald passes through the most active temperature range of the enzymes, giving optimum promotion for the few enzymes that are present. The soluble degradation products have a beneficial effect on freshness retention (shelf life). An improvement in the flavor of the bread can already be detected after the scald has matured for a standing time of 4 h.

Mash (boil)

For a mash, water and meal are boiled together. Dough yields of 300 are to be recommended, due to the almost complete starch gelatinization. However, because all the enzymes also denature at these temperatures of around 100 °C, no degradation of the gelatinized starches takes place.
Mash batches are mainly started using whole cereal grains or coarse meal. Boiling times are usually about 10–20 min, i.e. they are relatively short, and the amounts of about 10–15 % of the amount of raw material that are added for dough preparation are also less than for a cold soak or scald.
The amount of a mash that is added to a dough is smaller than for a cold soak or scald, because almost the whole of the starch is gelatinized and is no longer available for crumb formation. The water absorption of the dough is increased for the same dough firmness/cohesion, freshness retention (shelf life) is improved and defects caused by post-swelling grains are avoided. Adding too much mash is always at the expense of crumb elasticity. The consequences are lack of elasticity and settling of the crumb, especially at high dough yields.

Sourdough

A Detmold single-stage sourdough (DEF) was used for the baking experiments that were carried out. For this purpose a medium wholegrain rye meal was batched with an equal amount of water and 5 % mature sour (starter dough). The sourdough had an initial temperature of 27 °C and stood for approx. 16 h at room temperature. ▶

Recipe

Two batches of rye were processed in the context of the studies. Exclusively milled rye products with a low meal falling number of 98 sec were processed in baking series A, and milled rye products with a meal falling number of 150 sec, which is closer to actual practice, were used in baking series B. After milling the batches separately to yield coarse and medium wholegrain meal and wholegrain rye flour, wholegrain rye breads were manufactured with a 40 % proportion of pre-stage consisting of cold soak and mash. Recipe 1 did not contain any mash. The proportion was increased by 10 % in each further recipe. In exchange, to arrive at a total of 40 %, the proportion of cold soak was reduced by 10 % on each occasion from 40 % in Recipe 1, with the result that no cold soak was added to Recipe 5.

Table 2: Addition of different amounts of the various pre-stages to the main dough

Pre-stages	Bread 1	Bread 2	Bread 3	Bread 4	Bread 5
Mash TA 300 *Coarse wholegrain rye meal + water*	0%	10%	20%	30%	40%
Cold soak TA 200 *Coarse wholegrain rye meal + water*	40%	30%	20%	10%	0%
Sourdough DEF TA 200 *Coarse and medium wholegrain rye meal + water + starter*	38%	38%	38%	38%	38%

source: AGF

To enable only the effects of different proportions of cold soak and mash to be assessed, the added amounts of all the other ingredients, except for the amount of added water, were identical in all the recipes. The amount of sourdough added to the main dough was 38 % in each case. Because according to the guidelines a wholegrain rye bread must contain at least 90 % milled rye products and at least 90 % wholegrain milled products, approx. 10 % of Type 550 wheat flour was added to improve the crumb elasticity and to increase the volume. In addition, 2 % of salt and 1 % of fresh baker's yeast, relative to the milled cereals products, were added to each dough.

Manufacture

All the ingredients were mixed/kneaded twice for 10 min with a 15-min dough resting time, using the slow gear of a laboratory spiral mixer (Diosna). With all the doughs a "normal" dough firmness/cohesion was aimed at, and this was adjusted by the remaining amount of added water. The dough temperature was 29 °C. The dough was then loaded directly into baking pans. Final fermentation was assessed by a sensory test, and was between 70–80 min for all the breads. Baking took place in a multi-deck oven at a decreasing temperature from 260 °C to 180 °C for 120 min. The steam applied after loading was withdrawn again after 1 min. The total dough yield was calculated, and on the following day the baking loss and volume yield were determined. Next the breads were assessed by a sensory method. The other loaves were cut into slices, packed in heat-resistant bags and pasteurized in a multi-deck oven. Sensory tests of the breads took place after three, six, eight and twelve days.

Assessment

For the more enzyme-rich cold soak (meal falling number 98 sec) the pH after a floor time of 16 h was 0.7 units lower than for a cold soak using meal with a falling number of 150 sec. The long standing time of the cold soaks allowed acid-forming bacteria to reduce the pH and to increase the degree of acidity. In the scald, with the shorter floor time of 3–6 h, the acid-forming bacteria were able to reduce the pH by only a minimal amount. The highest pH was measured in the mash, because the bacteria and enzymes were inactivated immediately at high temperature.

Table 3: pH and acidity levels of the pre-stages

	Falling number [sec]	pH [units]	Degree of acidity [Sr°]
Cold soak	98	4.91	5.23
Scald	98	6.65	2.13
Mash	98	6.84	1.13
Cold soak	150	5.62	3.65
Scald	150	6.65	1.92
Mash	150	6.86	1.04

source: AGF

Because the mash had bound a very large amount of water due to the gelatinized starch, it was also necessary to increase the dough yield to achieve the same dough firmness with an increasing proportion of mash. The more water was added to the dough, the larger the baking loss became. Too much water in the dough also reduced the volume, and the bread became more compact. With the same recipes, baking series B always had a higher dough yield than baking series A, the volume yields turning out higher in all cases in baking series A.

Table 4: Baking results of baking series A (falling number 98 sec)

Proportion of mash	0%	10%	20%	30%	40%
Dough yield	177	183	188	192	196
Baking loss [%]	13.5	13.4	13.6	14.4	14.6
Volume yield [ml/100 g]	262	257	255	257	253

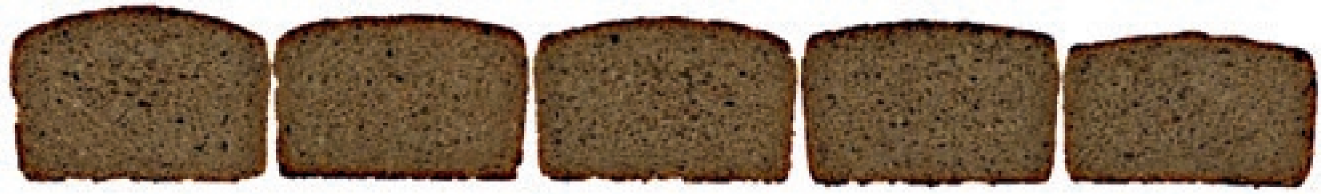
Table 5: Baking results of baking series B (falling number 150 sec)

Proportion of mash	0%	10%	20%	30%	40%
Dough yield	178	185	193	198	203
Baking loss [%]	13.7	13.6	14.1	14.5	15.0
Volume yield [ml/100 g]	250	249	242	245	240

source: AGF

Sensory assessment

Whereas the crumb moisture and crumb structure of the two baking series without mash were still "good", the crumbs with a higher proportion of mash were always more moist, more sticky and less elastic. With the same proportion of mash, the breads of baking series B (falling number 150 sec) were slightly drier than the breads of baking series A (falling number 98 sec). The dough yields, which increased as the



++ **figure 5**
Wholemeal breads from baking series A, proportion of mash from 0 to 40% (bread 1 to bread 5 from left to right)

++ **figure 6**
Breads from baking series B, proportion of mash from 0 to 40% (bread 1 to bread 5 from left to right)

proportion of mash rose, also affected the flavor. Whereas this was still "slightly acidic" without any mash, a 10 % to 20 % proportion of mash caused an "aromatically rounded taste". At a 30 % proportion of mash and above, the flavor moved in the "flavor-deficient" direction, and a mash taste was clearly perceptible. On the first day the bread with a 20 % proportion of mash from baking series B was assessed as the best bread, because the 20 % of mash in baking series A caused a damp, sticky bread crumb. After storage for 12 days, the crumb moisture in all the breads was classified towards "dry". In both baking series, the crumbs of the breads with a 30 % and a 40 % proportion of mash remained moist and sticky in spite of the long storage time, and were thus inedible. Based on the classification towards "dry", it was now possible to assess the bread from baking series A with a 20 % proportion of mash as optimum. On the first day this was still too moist and too sticky to be edible.

Processing instructions

With enzyme-deficient milled products, bakeries should use scalds in order to promote enzyme activity in the optimum temperature range. Milled products with strong enzyme activity should be processed in cold soaks. Although these have a longer standing time, the activity of the enzymes is inhibited at temperatures below 30 °C. There is a danger of extraneous fermentation, which can be avoided by adding salt. In the bakery, mashes are a good way of influencing the water absorption of meals, thus contributing to good baked product quality. The use of amounts up to 20 % promotes freshness retention (shelf life). Larger added amounts impair crumb elasticity, especially at high dough yields. Coarser meals with lower falling numbers (< 120 sec) are advisable when manufacturing wholemeal rye breads. Due to their degree of fineness and therefore more effective enzymology, wholegrain rye flours should have falling numbers greater than 180 sec. +++

Table 6: Properties of the breads from baking series A after storage for 1 day (on pale background) and after storage for 12 days

Proportion of mash	0%	10%	20%	30%	40%
Crumb moisture	normal	normal/slightly moist	slightly moist	moist	moist
Crumb structure	good	good	slightly sticky	sticky	very sticky
Flavor	slightly acidic	aromatic	aromatic rounded	not very aromatic, slight cooked taste	little flavor, cooked taste
Crumb moisture	dry	slightly dry	normal	slightly moist	moist
Crumb structure	good	good	good	slightly sticky	sticky
Flavor	slightly acidic	aromatic	aromatic rounded	not very aromatic, slight cooked taste	little flavor, cooked taste

source: AGF

Table 7: Properties of the breads from baking series B after storage for 1 day (on pale background) and after storage for 12 days

Proportion of mash	0%	10%	20%	30%	40%
Crumb moisture	normal, slightly dry	normal	normal	slightly moist	moist
Crumb structure	good	good	good	slightly sticky	sticky
Flavor	slightly acidic	aromatic	aromatic rounded	not very aromatic, slight cooked taste	little flavor, mash taste
Crumb moisture	dry	dry	normal / slightly dry	slightly moist	slightly moist
Crumb structure	good	good	good	slightly sticky	sticky
Flavor	slightly acidic	aromatic	aromatic rounded	not very aromatic, slight cooked taste	little flavor, cooked taste

source: AGF