NOTE

Barley Starch. VII. New Barley Starches with Fragmented Granules[1]

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ABSTRACT

Franubet and Wafranubet are new barley varieties characterized by small, fragmented starch granules. Pasting characteristics and other properties of the starches were compared with those of Betzes and Nubet starches. The Franubet and Wafranubet starches are more resistant to attack by α-amylase than are barley starches with normal granule configurations. Both starches show normal swelling power, but waxy starches such as that from Wafranubet usually have higher swelling power values.

A barley variety developed at Montana State University has small, polygonal starch granules rather than the globular granules usually found in barley starch. The polygonal shapes of these granules have prompted use of the term "fragmented" in describing their appearance.

This characteristic was obtained by induced mutation in a hulless (nude) variety of Betzes barley (Nubet). The new variety was called Franubet. A further derivative came from the incorporation of the waxy gene to yield a waxy, fractured, hulless variety named Wafranubet.

This investigation was undertaken to study the properties and characteristics of the starches from these new varieties.

MATERIALS AND METHODS

Preparation of Starches

The barley varieties were bred and grown at the Montana Agricultural Experiment Station. The starches were separated by wet milling according to the procedure described previously (DeHaas et al 1978).

Determinations

Protein content was determined by the Kjeldahl method (AOAC 1975). Total free fat was determined by ether extraction (AOAC 1975), and the samples were ashed according to the usual procedures (AOAC 1975). Iodine affinity was determined by the technique of Schoch (1964), modified by the use of dimethyl sulfoxide to defat the sample by the method of Banks et al (1971). Starch was determined by the method of Bauer and Alexander (1979), except that glucose was determined by the glucose oxidase procedure (Banks and Greenwood 1971). Brabender viscosities were determined by the procedure described by Smith (1964). The slurries contained 8% starch (dry basis) and 200 mg of mercuric chloride. The latter nullified the effect of residual α-amylase, as reported by Goering and Eslick (1976). The pasting temperature range was determined by amylograms in the presence of carboxymethyl cellulose (CMC) as described by Crossland and Favor (1948) and modified by Sandstedt and Abbott (1964). The CMC, which was of medium viscosity, was obtained from Sigma Chemical Company. Brabender viscosities were also determined at 7% starch in the presence of 0.0001% α-amylase (HT-1000 obtained from Miles Laboratories, Inc.). Swelling power and solubilities of the starches were determined at 85°C by the method of Leach et al (1959).

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RESULTS AND DISCUSSION

The chemical compositions of the Betzes, hulless Betzes (Nubet), fractured hulless Betzes (Franubet), and waxy fractured hulless Betzes (Wafranubet) are given in Table I. As expected, the protein contents are high because no alkali was used in the starch separation. The values for ether extractables are lower than those usually found, but they are not unprecedented (Goering et al 1973).

The Nubet starch granules have the normal rounded shape of barley starches, but the Franubet granules are generally much smaller and have angular, irregular shapes (Fig. 1). All starch samples were isolated under conditions that were not expected to cause significant starch damage. The Franubet starch appears shattered or crushed. The term "fragmented" was adopted to describe the starch granules from Franubet, Wafranubet, and related lines.

Brabender amylograms of the starches are given in Fig. 2. The waxy starch, Wafranubet, which is typical of waxy barley starches, pastes about 20°C lower than normal barley starches. The properties of the starches are given in Table II. The percent solubles is appreciably higher for Wafranubet starch, but the swelling power is essentially the same for all barley starches in this series. Wafranubet thus differs in swelling power from other waxy barley starches that have much higher swelling power values than their nonwaxy counterparts (Goering et al 1973).

The iodine affinity of the Wafranubet starch is 0.9%, indicating amylose content of approximately 5%. The other iodine affinity values indicate that the starches are normal barley starches with 26–28% amylose. The pasting characteristics of the starches in the presence of CMC are shown in Fig. 3. Wafranubet starch is gelatinized in two stages: first between 70 and 75°C, and finally at 95°C. The higher temperature may be due to the presence of the amylose. The nonwaxy starches gelatinize slightly between 60 and 70°C, but principal pasting occurs at 92°C.

The effect of α-amylase on the various starches is illustrated in Fig. 4. The fractured starches were much more resistant to the action of α-amylase than was the Nubet starch. The high viscosity of the Wafranubet starch in the presence of HT-1000 was

TABLE I
Chemical Composition of the Starches[a]

Sample	Starch (%)	Protein (%)	Ash (%)	Ether-Extractable (%)
Betzes	94.8	0.88	0.23	0.08
Nubet	97.2	0.60	0.30	0.06
Franubet	97.2	1.22	0.22	0.06
Wafranubet	96.9	1.07	0.16	0.11

[a]All figures adjusted to dry basis.

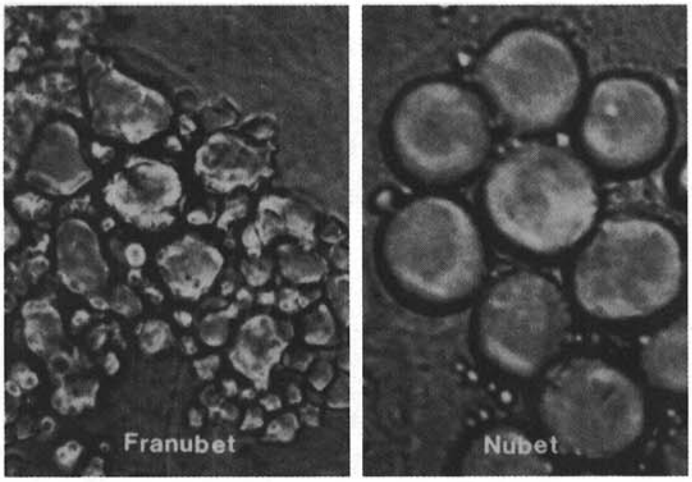

Fig. 1. Photomicrographs of starch granules of Franubet and Nubet barleys.

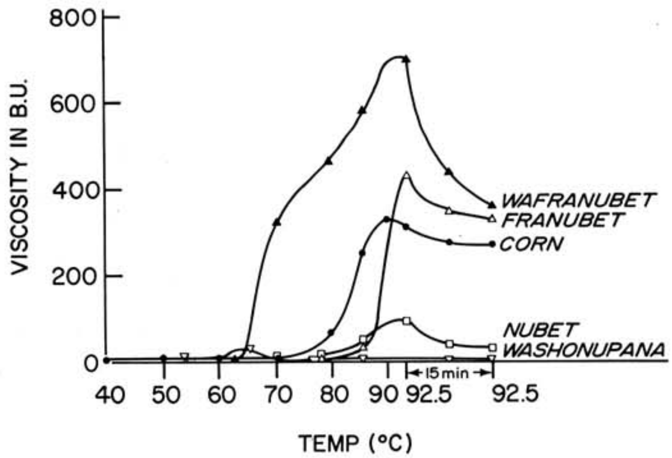

Fig. 4. Brabender amylograms at 7% starch level plus 0.0001% HT-1000.

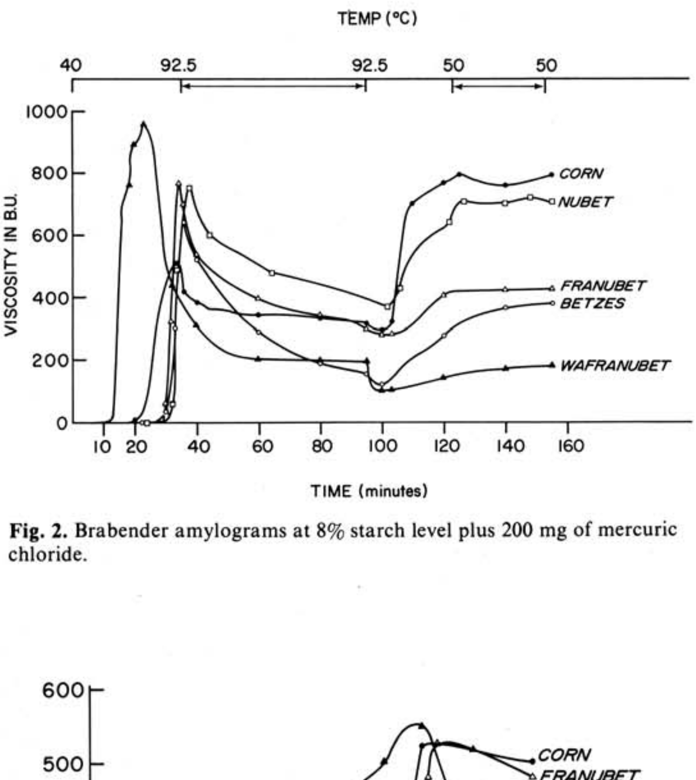

Fig. 2. Brabender amylograms at 8% starch level plus 200 mg of mercuric chloride.

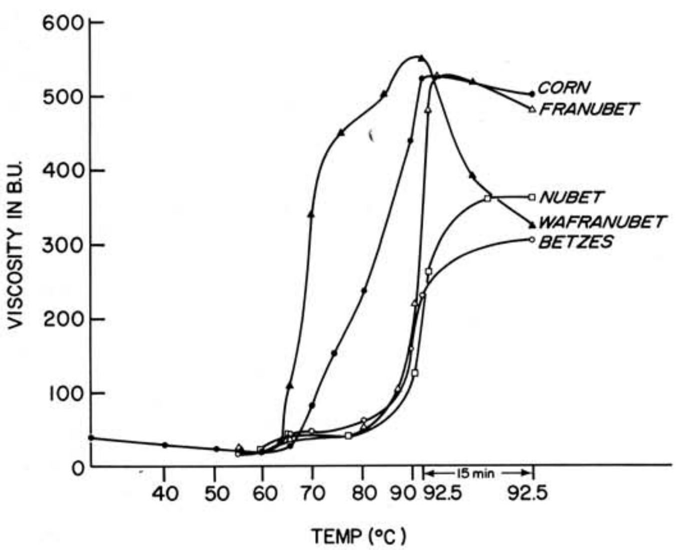

Fig. 3. Pasting curves of starches, 5.5% starch plus 0.8% carboxymethyl cellulose.

TABLE II
Properties of the Starches

Sample	Solubles (%)	Swelling Power	Iodine Affinity (%)
Corn	...	...	5.2
Betzes	5.4	7.8	5.2
Nubet	3.5	8.2	5.2
Franubet	6.4	8.0	5.6
Wafranubet	14.1	7.8	0.9

unexpected because other waxy barley starches have been very readily attacked by α-amylase (Goering and Eslick 1976, Goering et al 1980). The cooking curve of Washonupana (waxy, short awn, nude Compana) starch in the presence of HT-1000 is shown for comparison. Susceptibility to α-amylase cannot be correlated with granule size. The starches of *Colocasia esculenta* are characterized by small granules resistant to α-amylase (Goering and DeHaas 1972), but the starches of the small-granule cow cockle and of the medium-granule canary grass are readily liquified by α-amylase (Goering and Brelsford 1966, Goering and Schuch 1967). This relationship between structure and starch properties has been discussed by Goering (1978). An attempt to use the Wafranubet barley in the maltose syrup process (Goering et al 1980) was not successful because the barley-water slurry had poor handling characteristics, and starch conversion was poor.

The starches from Wafranubet and Franubet are unique among barley starches in their great resistance to attack by α-amylase, especially when compared with cornstarch and dasheen (*Colocasia esculenta*) starches. It seems logical to examine this property when characterizing new starches. A correlation may exist between α-amylase susceptibility and the digestibility of starch used as animal feed.

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