A study of the consistency of starch gels prepared at a higher altitude
by Jean T Chase

A THESIS Submitted to the Graduate Committee in partial fulfillment of the requirements for the degree of Master of Science in Home Economics
Montana State University

Abstract:
Starch gels made with corn starch or all-purpose flour tad using as liquid distilled water, tap water and milk, respectively, were prepared under high altitude conditions for the purpose of studying their relative consistencies. Their qualities and breaking strengths (measured on the Delaware jelly strength tester) were compared with those of a standard gel.

It was found that at an altitude of 4700 feet above sea level where the boiling point ef water is about 95.5°C., more complete gelatinization and better gels could be obtained when the starch paste was cooked ever direct beat and allowed to boll only five minutes. This method was preferred to that of cooking in a boiling water bath where the temperature of the starch past# was too low to insure complete geleatinzation.

There was a definite indication that the presence ef ash or salts in tap water, milk and flour had a depressing offset on the thickening property of the starch and lowered the brooking strength ef the gels. When 20 per cent ef sugar was added to the pastes, the gel strength was slightly increased. When a larger amount of sugar (60 per cent) was added to the pastes, the resulting gels were decidedly weaker than the standard. To obtain complete starch gelatinization under the latter conditions, it was necessary to withhold one-half of the sugar until the end of the cooking period. If fruit acid was also added to the gel at the end of the decking period. it had no apparent effect on the gel strength.

A STUDY OF THE CONSISTENCY OF STARCH GELS PREPARED AT A HIGHER ALTITUDE

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ABSTRACT

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INTRODUCTION

Starch is an important granular material produced only by plants and constitutes one of the forms in which plants store their carbohydrate. One of the characteristics of starch that is responsible for its extensive use in commercial and home processes, is its thickening or gel-forming property. When starch granules are added to water they swell slightly and form a paste, which upon heating to a certain temperature, thickens or gelatinizes. By controlling the proportions of starch and water and heating the paste to a definite temperature, there results a cooked product that gelatinizes when cooled and forms a standard gel. It is understood that a standard gel holds its shape when removed from a mold, shows no syneresis or weeping, quivers when gently moved, and has a jelly-like texture exhibiting a smooth continuous surface when sheared.

In cookery, starch gels are frequently used for such products as puddings and pie-fillings. For this purpose the starch is usually obtained from either corn starch or flour. The former contains little besides starch, but flour is a composite substance, having various amounts of protein and ash in addition to the starch, and all of the ingredients must be considered. An examination of so-called reliable recipes for starch gels show that they do not agree in the relative amounts of starch used. It is apparent that little comparative study has been made of the thickening or gel-forming power of corn starch and flour, and that little is known about the specific requirement of either corn starch or flour for making a standard gel.

Studies in recent years have shown that starches obtained from corn

and wheat are not always of a uniform quality. There are vague references in the literature to "thin-boiling" and "thick-boiling" starches, indicating that some inherent characteristic of the starch must affect its gelatinization.

Another factor that seems to affect starch gelatinization is the elevation above sea level at which starch is cooked. With elevation comes a lowering of the boiling point of water so that the cooking temperature may fall below the gelatinization point of some starches. Whether failure of starch to gel is due to the lowered cooking temperature, faulty proportions of ingredients or poor quality of starch is still a problem. At times, this difficulty of obtaining gelatinization in starch cookery is reported by homes and institutions at higher altitudes.

In preparation of starch gels for food, other materials such as sugars, salt, fruit acids, milk and chocolate, are often added to increase palatability. It is desirable to determine how these added ingredients will affect the final consistency of starch gels.

While some limited observations on starch cookery problems have previously been made under conditions at sea level, this study proposes to further investigate starch gelatinization at a higher altitude by determining the effect of a lowered cooking temperature with varied proportions of ingredients.

HISTORY

Before attempting to study starch gel formation and its uses in cookery, it is necessary to thoroughly understand the physical and chemical nature of starch, its basic qualities and its variations.

Starch, the form in which plants store their reserve carbohydrate, makes up a large part of such foods as the cereal grains (wheat, corn, and oats) and potatoes. Raw starch granules taken from different plants and examined under the microscope vary greatly in size and shape, those from wheat and corn ranging from 3 to 35 microns in diameter. The granules may be round or oval and may occur singly or in aggregates of 2 to 25 or more.

Ordinarily starch is not used in its natural raw state but is subjected to a refining process consisting of a series of washings with water, acid and salt solutions, bleaches, alcohol and ether, that remove undesirable ingredients and increase the thickening property (44). The composition of commercial corn starch, called a pure starch after refining, is 87 per cent carbohydrate and 12 per cent water, while flour, a wheat starch, contains about 75 per cent carbohydrate, 12 per cent water, and about 11 per cent protein (11). In addition, both starches contain small amounts of fat and ash. This difference in composition partly accounts for the variation in thickening capacity of corn starch and wheat flour.

Some workers have regarded starch as a homogeneous colloidal substance and thought that variations in its characteristics were due to different colloidal conditions. However, Samec (27) and others believe that starch is a heterogeneous system built up from polysaccharides together with organic or inorganic substances. Changes in the non-starch components would then modify the properties of the starch.

From a chemical viewpoint, the starch particle is made up of two fractions, a less soluble portion called alpha-amylose or <u>amylopectin</u>, which forms a viscous opalescent paste on heating in water; and a more soluble portion known as beta-amylose or <u>amylose</u>, which upon heating forms a clear liquid