# THE EFFECT OF VARIOUS GLYCERIDES ON THE BAKING PROPERTIES OF STARCH DOUGHS[1]

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## ABSTRACT

The addition of small quantities (0.1%) of saturated monoglycerides and monodiglycerides to starch doughs made with and without shortening produced gross improvements in the crumb structure of the resultant bread. A corresponding series of compounds of the unsaturated type did not exhibit improving effects. At elevated dough temperatures (102°F.) the unsaturated materials caused failure of doughs during proofing and baking. At 1% usage level, triglycerides which are plastic within the temperature range of mixing and fermentation improved the volume of starch breads but failed to improve grain.

For many years the role of starch as it relates to the structure of dough prior to and during baking has been given little consideration, the basic and important rheological properties of dough being attributed to the gluten structure developed during mixing.

However, some European workers, notably Rotsch (1,2), Hess (3), and more recently Jongh (4), have made some interesting observations regarding the role of starch in doughs. In his work, Jongh (4) made use of glyceryl monostearate to achieve a gluten-free dough which had something approaching normal gas-retention properties and which after baking had a fine breadlike grain structure. The monoglyceride used in his experiments was of the self-emulsifying, saturated type with a total monoglyceride content of approximately 50%. It was added to the dough in the form of an aqueous dispersion. Significant changes in crumb characteristics of the breads produced were reported with quantities as low as 0.05% based on weight of starch in the formula.

Jongh limited his study (4) to the effect of the one saturated glyceryl monostearate just described, chosen on the basis of the theoretical consideration that it would act as a starch-flocculating agent. A considerable portion of his paper is devoted to a demonstration of this ability of the saturated glyceryl monostearate and to speculations as to how this effect might influence the observed rheological properties of starch doughs.

The implications of Jongh's findings are, of course, that the proper-

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ties of ordinary bread doughs may be influenced to a considerable extent by starch-flocculating agents, such as the glyceryl monostearate described, and that these mechanisms may play an important role in determining bread quality. This work poses the immediate question as to how the monoglyceride-containing materials used in commercial practice may influence the starch phase of doughs.

A wide variety of monoglyceride types are used by the baking industry, which vary not only in mono-, di-, and triglyceride ratios, but also as to degree of saturation. This paper presents the results obtained in studies on starch bread with two series of monoglyceride-containing materials representative of the types generally used in commercial bread-baking, one of the saturated and the other of the unsaturated type.

In the work reported by Jongh, the effect of triglycerides on starch doughs and bread was not considered. The present study includes an investigation of the effect of triglycerides and of monoglycerides in the presence of larger amounts of triglycerides, as is the situation in ordinary bread doughs.

## Materials and Methods

*Materials.* A commercial grade of unmodified wheat starch with a protein content of 0.3% and moisture content of 10.25% was used.

The monoglycerides and the monodiglycerides were also obtained from commercial sources. One series was of the fully saturated type; the second series was of the unsaturated-type compounds. The iodine values, alpha-monoglyceride contents, and calculated diglyceride contents of the six materials are shown in Table I.

TABLE I

IODINE VALUES AND MONO- AND DIGLYCERIDE CONTENTS OF MATERIALS

| Saturated Series | | | Unsaturated Series | | |
|---|---|---|---|---|---|
| I.V.[a] | Alpha-Monoglycerides[b] | Diglycerides | I.V. | Alpha-Monoglycerides | Diglycerides |
| | % | % | | % | % |
| 1 | 90 | . . | 50 | 90 | . . |
| 1 | 55 | 32 | 50 | 55 | 32 |
| 1 | 40 | 54 | 50 | 40 | 54 |

[a] Reference 5, Method 41.2.
[b] Reference 5, Method 51.2.

So that the saturated materials would be in a dispersible state, all the materials were made into aqueous dispersions containing 25% solids. These dispersions were prepared by adding the monoglyceride material to water at a temperature slightly exceeding the melting point of compound used. The water was placed in a high-shear laboratory mixer and, after the monoglyceride was added, agitation was continued until cooling was sufficient to yield a thick, creamy dispersion.

The triglycerides used included soy oil, lard, and lard containing 10% fully hydrogenated cottonseed oil.

*Baking Tests.* In the first group of experiments, starch doughs were prepared with a Hobart C-100 mixer equipped with a McDuffee bowl. The actual doughs prepared utilized 300 g. of starch corrected to 14% moisture basis. Absorption was held constant throughout the series.

The basic formula expressed in baker's percentages was:

| | % |
|---|---|
| Wheat starch | 100 |
| Corn sugar | 4 |
| Salt | 2 |
| Yeast | 6 |
| Shortening (when used) | 1 |
| Monoglyceride dispersion | 0.4 |
| Water | 66 |

In the series of experiments evaluating the effects of monoglycerides in the presence of shortening, lard was used.

The procedure was essentially a straight-dough method with all ingredients placed in the bowl and mixed 1 min. in first speed and 5 min. in second speed. The dough produced had the consistency of a very heavy batter and was scaled directly into the pan. Final dough temperature was 80°F.

Proofing was for 50 min. (at 100°F. and 90% relative humidity), at which time the doughs with good gas-retention properties were just above the top of the pan. The proofed doughs were baked at 425°F. for 25 min.

Experimental doughs in the second group were mixed in a Brabender Dō-Corder under conditions approximating those of continuous doughmaking processes. The percentage formula used was identical to that previously described, with the exception that the absorption was increased from 66 to 69%. Doughs were formulated on the basis of 750 g. of starch at 14% moisture.

A mechanical stirrer was used to form a smooth slurry of all the ingredients, in a beaker. After 2 min. of mixing, the slurry was placed in the Dō-Corder and mixed 60 sec. at 215 r.p.m. The final dough temperature was 102°F. Proofing and baking were carried out in the manner previously described.

## Results

*Effect of Monoglycerides and Monodiglycerides on Fat-Free Starch Breads.* Figure 1 shows the effect of 0.1% of the saturated compound when added to doughs mixed in a conventional laboratory mixer. The finished dough temperatures were 80°F. Figure 2 shows the effect of the same series of saturated compounds on doughs mixed in the Dō-Corder where the final temperature was 102°F. All of these loaves show a marked improvement in grain as compared to the control.

Figure 3 shows the analogous series of unsaturated compounds used at 0.1% in doughs mixed in the conventional laboratory mixer. Figure 4 shows the corresponding loaves mixed in the Dō-Corder. Failure in the proof box occurred with the 90% alpha-monoglyceride material at the 80°F. dough temperature. When mixed in the Dō-Corder all three unsaturated compounds produced doughs with very poor gas-retaining properties and stability, with resulting failure in the proof box.

*Effect of Triglycerides on Starch Breads.* Initial experiments with triglycerides of various iodine values were carried out at usage levels

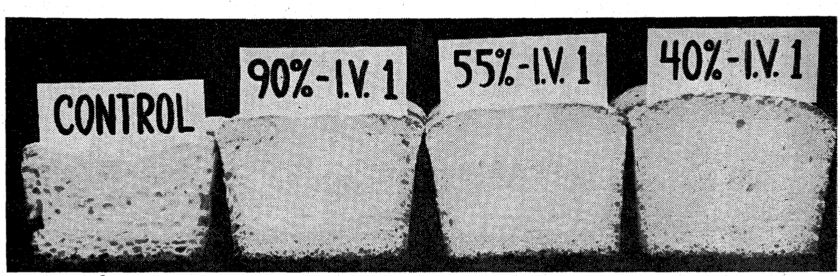


Fig. 1. Fat-free starch bread made with saturated monoglyceride and monodiglycerides at 0.1% usage level based on starch. Dough temperature 80°F.; Hobart mixer. Percentages refer to alpha-monoglyceride.

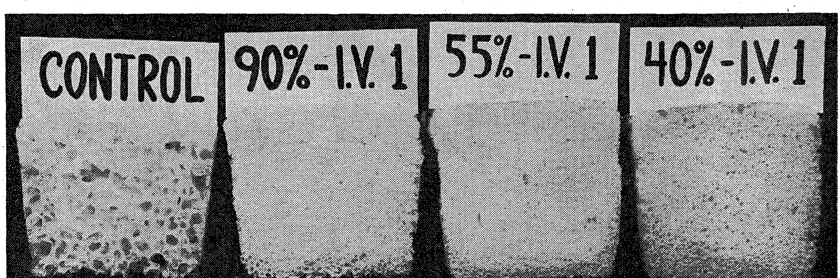


Fig. 2. Fat-free starch bread made with saturated monoglyceride and monodiglycerides at 0.1% usage level based on starch. Dough temperature 102°F.; Dō-Corder. Percentages refer to alpha-monoglyceride.

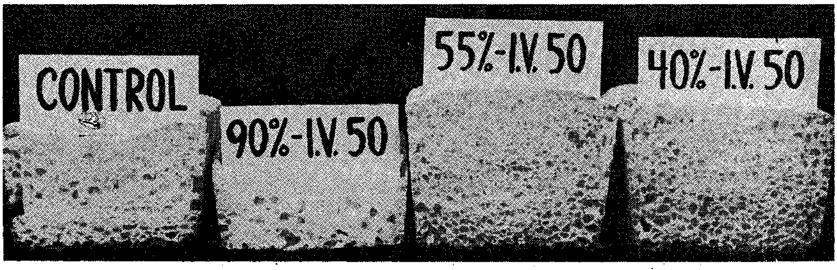


Fig. 3. Fat-free starch bread made with unsaturated monoglyceride and monodiglycerides at 0.1% usage level based on starch. Dough temperature 80°F.; Hobart mixer. Percentages refer to alpha-monoglyceride.

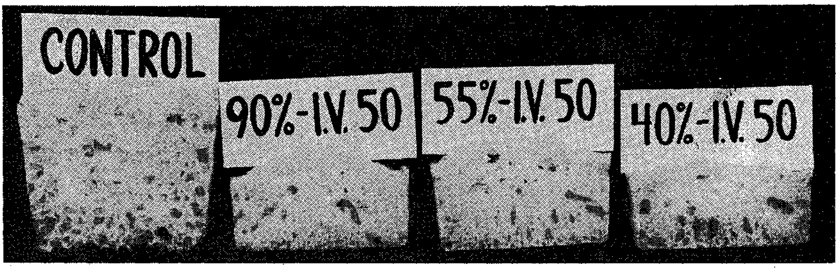


Fig. 4. Fat-free starch bread made with unsaturated monoglyceride and monodiglycerides at 0.1% usage level based on starch. Dough temperature 102°F.; Do-Corder. Percentages refer to alpha-monoglyceride.

of 0.1% No effect was evident, indicating that the changes observed in starch breads made in the preceding experiments with monoglycerides and monodiglycerides were not merely the result of the addition of fatty material to the doughs. At a 1% usage level, however, certain triglycerides did produce a noticeable change in the character of the bread. Figure 5 illustrates these results. Loaf volume improved when the fat was plastic in the temperature range encountered during mixing and fermentation, but there was no improvement in grain.

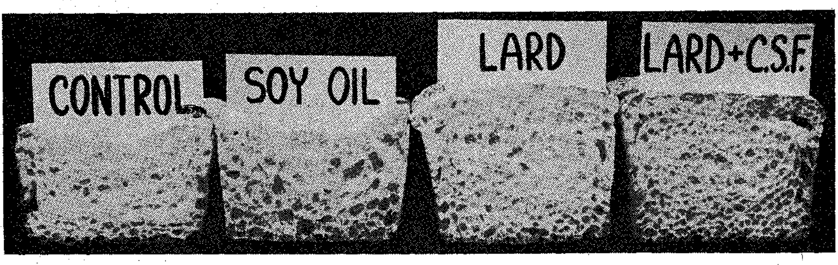


Fig. 5. Triglycerides at 1% usage level based on starch. Extreme right, lard containing 10% by weight fully hydrogenated cottonseed oil.

*Effect of Monoglycerides and Monodiglycerides in the Presence of Triglyceride.* The remaining illustrations demonstrate the ability of monoglyceride-containing materials, when used in the presence of larger amounts of triglyceride, to alter the characteristics of starch breads. The triglyceride in all examples was lard and usage level was 1%. All monoglyceride compounds were introduced at a 0.1% level. Figure 6 shows the saturated series in breads mixed with a conventional mixer at 80°F. Figure 7 shows the Dō-Corder series. As in the

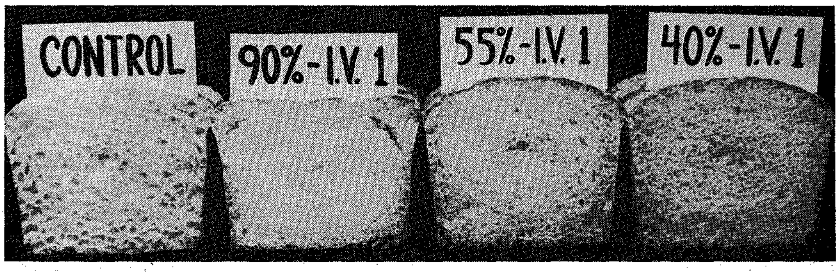


Fig. 6. Starch bread containing 1% lard with saturated monoglyceride and monodiglycerides at 0.1% usage level. Dough temperature 80°F.; Hobart mixer. Percentages refer to alpha-monoglyceride.

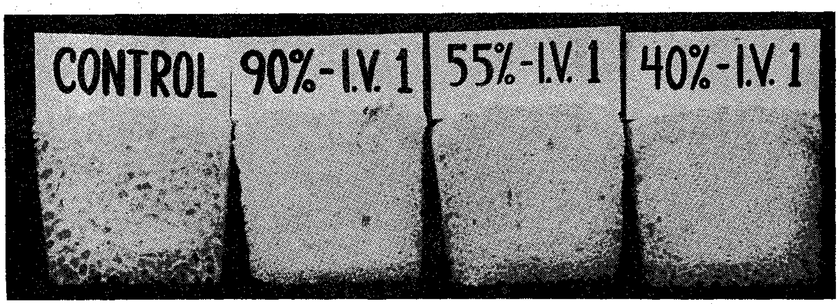


Fig. 7. Starch bread containing 1% lard with saturated monoglyceride and monodiglycerides at 0.1% usage level. Dough temperature 102°F.; Dō-Corder. Percentages refer to alpha-monoglyceride.

fat-free bread experiments, pronounced improvements in grain resulted with each of the saturated materials. In the presence of lard there was no change in loaf volume. Crumb was finest in the breads made with the material containing higher percentages of alpha-monoglyceride.

Figure 8 again shows the series of unsaturated compounds in bread containing 1% lard made with the conventional mixer. Improvement in grain was in each case accompanied by a loss in loaf volume. The similar series made with the Dō-Corder is shown in Fig. 9. The bread

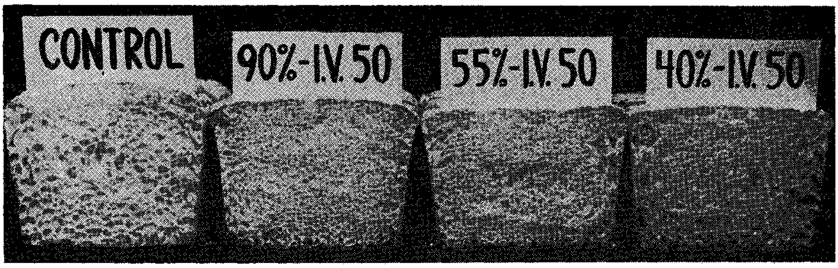


Fig. 8. Starch bread containing 1% lard with unsaturated monoglyceride and monodiglycerides at 0.1% usage level. Dough temperature 80°F.; Hobart mixer. Percentages refer to alpha-monoglyceride.

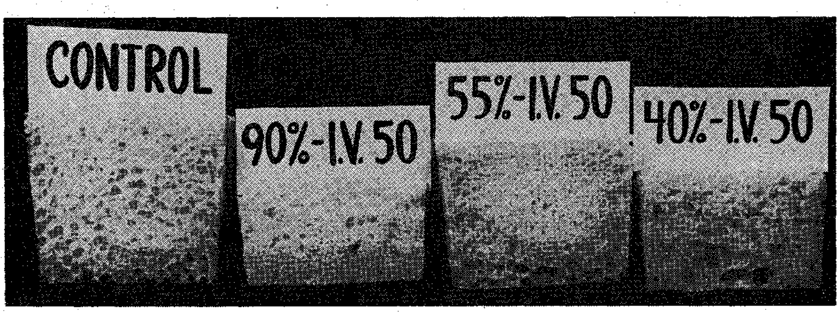


Fig. 9. Starch bread containing 1% lard with unsaturated monoglyceride and monodiglycerides at 0.1% usage level. Dough temperature 102°F.; Dō-Corder. Percentages refer to alpha-monoglyceride.

produced with each of these three materials was inferior to the control with respect to volume as a result of poor gas retention in these doughs during baking.

## Discussion

The behavior of yeast-fermented starch doughs can be grossly affected by the addition of small quantities of certain monoglycerides. Significant changes in the structure of the finished starch breads occurred at a 0.1% usage level based on total starch in the formula. Throughout the series, the degree of saturation appeared to be of greater significance than the mono- to diglyceride ratio, the fully saturated materials being considerably more effective in influencing structure in a desirable manner.

In the fat-free starch doughs, materials containing higher proportions of diglycerides produced starch breads with the most desirable structure regardless of mixing procedure.

In the presence of fat, starch breads were finest and most even-textured with the materials containing the highest percentage of alpha-monoglycerides. However, these differences were small. In every instance, the saturated material was superior in this respect to the analogous unsaturated compound. At the higher temperatures in the Dō-Corder series, the unsaturated monoglycerides had a definitely adverse effect on structure.

Those triglycerides which are plastic in the temperature range encountered in mixing and fermenting had an improving effect on starch bread volume when used at a 1% level. This effect was approximately equivalent to that obtained with 0.1% of the unsaturated monoglycerides containing 50% or less alpha-monoglyceride. Cell structure in either case was coarse and open.

At dough temperatures of 80°F. the unsaturated monoglycerides improved grain somewhat when used in combination with lard. The improving effects of saturated monoglycerides were masked to some extent by the addition of lard. Under the conditions approximating continuous mix this masking effect was considerably less apparent, and breads thus produced were the best in the entire series.

These results clearly show that the properties of starch doughs and the quality of the resultant bread can be appreciably affected by the addition of various combinations of mono-, di-, and triglycerides. Saturated monodiglycerides consistently had a pronounced improving effect on structure. The implications are that such effects may be of significance in actual bread production, particularly in continuous doughmaking processes where high dough temperatures and high absorption values are the rule. Further work is planned to determine the specific importance of these interrelationships in both conventional and continuous breadmaking processes.

**Acknowledgment**

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