EFFECT OF PRETREATMENT BY INSTANTANEOUS PRESSURE REDUCTION ON THE KINEMATIC VISCOSITY OF TOMATO PULP

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Abstract. The rheological properties of tomato pulp play an important role in its processing, particularly during pumping, heat transfer, and concentration by evaporation. This study investigates changes in the kinematic viscosity of tomato pulp following pretreatment under different process parameter values. Experimental measurements were obtained for product masses of 40, 50, 60, 70, 80, and 90, with treatment parameters of P = 1, 2, 4, 6, and 8. The results indicate that viscosity generally decreases as the treatment parameter increases, although the magnitude of the change depends on product mass. At a product mass of 90, the measured value decreased from 5.13 at P = 1 to 4.43 at P = 8, corresponding to a reduction of approximately 13.65%. At a product mass of 40, the value decreased from 10.22 to 10.11, representing a reduction of approximately 1.08%. These findings demonstrate that the response of tomato pulp to pretreatment is dependent on the experimental conditions. The observed reduction in viscosity may have practical implications for product flow and circulation during subsequent concentration. However, the relationship between viscosity and evaporation efficiency requires further verification under controlled processing conditions.

Keywords: tomato pulp, kinematic viscosity, rheological properties, instantaneous pressure reduction, pretreatment, product mass, evaporation, concentration.

Аннотация. Реологические свойства томатной пульпы имеют важное значение при её переработке, в частности при перекачивании, теплообмене и концентрировании выпариванием. В работе исследуется изменение кинематической вязкости томатной пульпы после предварительной обработки при различных значениях технологического параметра. Экспериментальные измерения представлены для массы продукта 40, 50, 60, 70, 80 и 90 при параметрах обработки P = 1, 2, 4, 6 и 8 Установлено, что измеренные значения вязкости снижаются с увеличением параметра обработки, однако степень изменения зависит от массы продукта. При массе продукта 90 вязкость уменьшилась с 5,13 при P = 1 до 4.43 при P = 8,

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что соответствует снижению примерно на 13,65 %. При массе продукта 40 показатель уменьшился с 10,22 до 10,11, то есть примерно на 1,08 %. Полученные результаты свидетельствуют о зависимости реологического отклика томатной пульпы от экспериментальных условий. Снижение вязкости может иметь практическое значение для течения и циркуляции продукта при последующем концентрировании. Вместе с тем связь между вязкостью и эффективностью выпаривания требует дополнительной проверки в контролируемых условиях.

Ключевые слова: томатная пульпа, кинематическая вязкость, реологические свойства, мгновенное снижение давления, предварительная обработка, масса продукта, выпаривание, концентрирование.

Annotatsiya. Mazkur maqolada tomat pulpasining dastlabki ishlov berishdan keyingi kinematik qovushqoqligi o‘zgarishi tadqiq etilgan. Tajribalar mahsulot massasining 40, 50, 60, 70, 80 va 90 qiymatlarida hamda ishlov berish parametrining rejimlarida o‘tkazilgan. Natijalar ishlov berish parametri ortishi bilan barcha o‘rganilgan mahsulot massalarida kinematik qovushqoqlikning kamayishini ko‘rsatdi. Mahsulot massasi 90 bo‘lganda qovushqoqlik da 5,13 dan da 4,43 gacha pasayib, 13,65 % ga kamaygan. Mahsulot massasi 40 bo‘lganda esa qovushqoqlik 10,22 dan 10,11 gacha kamayib, pasayish 1,08 % ni tashkil etgan. Olingan natijalar tomat pulpasining reologik xususiyatlari ishlov berish parametrlari va tajriba sharoitlariga bog‘liqligini ko‘rsatadi. Qovushqoqlikning kamayishi mahsulotning oquvchanligi va bug‘latish uskunasida aylanishini yaxshilashga yordam berishi mumkin. Biroq dastlabki ishlov berishning bug‘latish davomiyligi va energiya sarfiga ta’sirini aniqlash uchun qo‘shimcha tajribalar o‘tkazish zarur.

Kalit so‘zlar: tomat pulpasi, kinematik qovushqoqlik, reologik xususiyatlar, dastlabki ishlov berish, bosimni bir zumda pasaytirish, mahsulot massasi, bug‘latish, konsentrlash.

INTRODUCTION

Tomato pulp is a complex food system containing water, soluble solids, organic acids, sugars, pectin compounds, and insoluble plant tissue particles. Its rheological properties depend on the composition of the product, the concentration of solids, particle size distribution, temperature, and processing history.Viscosity is an important technological characteristic of tomato products because it influences their flow behavior during pumping, mixing, transportation, and thermal processing. Previous studies have demonstrated that tomato paste exhibits non-

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Newtonian behavior and that its rheological properties are strongly affected by solids concentration, temperature, and the characteristics of the dispersed phase.

During evaporation, the removal of moisture increases the concentration of solids and generally increases the viscosity of tomato pulp. Increased viscosity can affect circulation and mixing, alter the hydrodynamic conditions near heating surfaces, and complicate heat transfer.Pretreatment before evaporation may provide an opportunity to modify the structural and rheological characteristics of the product. In particular, instantaneous pressure reduction may change the physical structure of the pulp and, under appropriate conditions, cause partial evaporation of moisture. The resulting changes in particle structure, moisture distribution, and component interactions may affect the measured viscosity.

The objective of this study was to evaluate changes in the kinematic viscosity of tomato pulp after pretreatment at different process parameter values and to determine the potential technological significance of the observed changes for subsequent evaporation.

The experimental material was tomato pulp subjected to preliminary processing under different treatment conditions. The investigation covered six product masses: 90, 80, 70, 60, 50, and 40. The treatment parameter was varied at five levels: P = 1, 2, 4, 6, and 8

$$v = K * t$$

K = 1,111

The measured kinematic viscosity values of tomato pulp at different product masses and treatment parameters are presented in Table 1.

Table 1.

Kinematic viscosity of tomato pulp at different pretreatment parameters.

Product mass	P = 1	P = 2	P = 4	P = 6	P = 8
90	5.13	4.54	4.51	4.44	4.43
80	4.80	4.53	4.50	4.49	4.48
70	4.66	4.60	4.55	4.45	4.44
60	5.89	5.80	5.78	5.74	5.71
50	7.12	7.10	6.99	6.98	6.97
40	10.22	10.19	10.16	10.12	10.11

The results show that the measured viscosity decreases with increasing treatment parameter for all six product masses. However, the magnitude of the reduction varies considerably. For a product mass of 90, the viscosity decreased from 5.13 at P = 1 to 4.43 at P = 8. For a product mass of 80, the corresponding

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values decreased from 4.80 to 4.48. At a product mass of 70, viscosity decreased from 4.66 to 4.44.

For product masses of 60 and 50, the changes were comparatively smaller. The measured viscosity decreased from 5.89 to 5.71 and from 7.12 to 6.97, respectively. At a product mass of 40, the decrease was the smallest, from 10.22 to 10.11.

These findings indicate that the influence of pretreatment is not uniform across the investigated product masses. The largest absolute and relative reductions were observed at a product mass of 90, whereas the smallest relative reduction occurred at a product mass of 40.

The data demonstrate that increasing the treatment parameter from P = 1 to P = 8 was associated with lower measured viscosity values throughout the investigated range. Nevertheless, the magnitude of this effect depended on product mass and should not be represented by a single percentage for all samples.

The reduction in measured viscosity may be associated with changes in the structural organization of tomato pulp during pretreatment. Tomato products contain dispersed plant tissue particles and pectin-rich components that contribute to their flow resistance. Changes in particle size distribution and structural interactions can modify their rheological behavior.

Pretreatment involving pressure reduction may also alter moisture distribution and the physical state of the dispersed phase. However, these mechanisms cannot be confirmed from viscosity measurements alone.

Tomato pulp is a complex dispersed system consisting of a liquid phase, suspended pulp particles, cellular structures, fragments of plant tissue, and fibrous components. Its rheological properties depend on the concentration of soluble and insoluble solids, particle distribution, and interactions between structural elements. During evaporation, moisture removal increases the concentration of the product, generally resulting in an increase in viscosity.

The experimental observations indicate that the kinematic viscosity of tomato pulp increases as the product mass decreases from 90 g to 40 g during evaporation. This behavior can be attributed primarily to moisture removal and the resulting concentration of nonvolatile components. As the concentration of suspended solids increases, interactions between dispersed particles become more pronounced, potentially increasing resistance to flow. However, viscosity changes are not necessarily linear because they may also be influenced by modifications in particle distribution, aggregation, and the internal structure of the pulp.

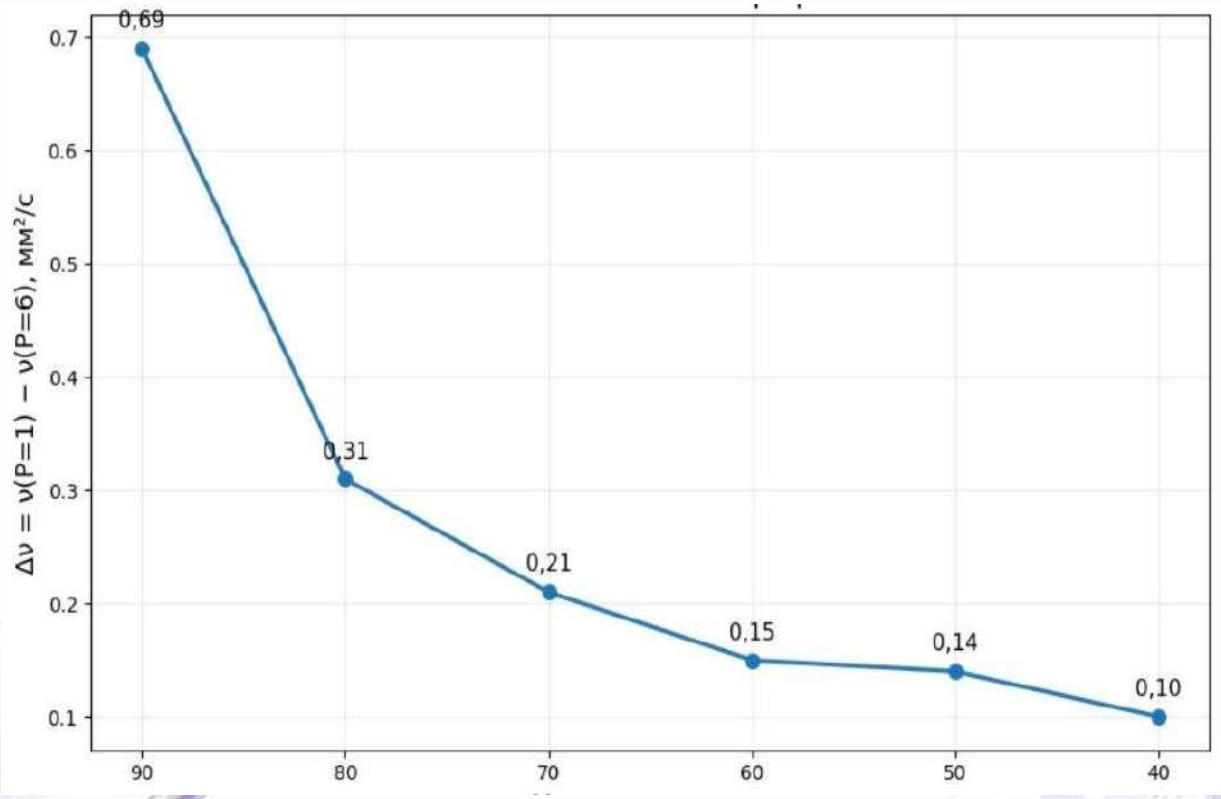
Comparison of untreated and pretreated tomato pulp indicates that, at almost all investigated points, the kinematic viscosity after pretreatment by a sudden pressure drop is lower than that of the untreated reference sample. This observation

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suggests that pressure-drop pretreatment may modify the structural organization of the pulp and reduce its resistance to flow. To distinguish the effect of pretreatment from the effect of concentration, the viscosity values should be compared at equivalent pulp masses or, preferably, equivalent solids concentrations.

Untreated tomato pulp contains numerous structural elements that interact with one another and contribute to the formation of a dispersed structural network. These interactions influence the mobility of the liquid phase and the overall resistance to flow. During evaporation, the increasing concentration of suspended and dissolved components can intensify particle interactions and contribute to an increase in viscosity.

During pretreatment by a sudden pressure drop, rapid decompression may cause the expansion of entrained gas bubbles and generate transient local hydrodynamic effects. Depending on the treatment conditions and the physical properties of the pulp, these effects may contribute to the disruption of certain aggregates, changes in particle distribution, and modification of cellular structures. Such changes could weaken some interactions within the dispersed system, thereby reducing resistance to flow and lowering the kinematic viscosity of the pretreated product. However, these mechanisms should be considered possible explanations unless confirmed by independent microstructural analysis.



An important consideration is that the viscosity response of tomato pulp depends on temperature and solids concentration. Consequently, the observed

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differences can be attributed specifically to the pretreatment parameter only if these other variables were adequately controlled.

The experimental results also show that the absolute viscosity values differ between product masses. The highest measured value was 10.22 at a product mass of 40 and P = 1, whereas the lowest was 4.43 at a product mass of 90 and P = 8. These differences suggest that product mass or an associated experimental condition may influence the measurement. The mass values should therefore be defined clearly before drawing conclusions about the independent effect of treatment.

Viscosity is an important factor in the hydrodynamic behavior of tomato pulp during concentration. A reduction in viscosity can potentially facilitate pumping, mixing, and product circulation through evaporation equipment.

The decrease observed after pretreatment may therefore be technologically beneficial if it persists under the operating conditions of the evaporation stage. However, the relationship between viscosity and evaporation performance is not direct. A reduction in viscosity does not, by itself, prove that evaporation time or energy consumption will decrease. Evaporation also depends on heat-transfer characteristics, solids concentration, operating pressure, temperature, product circulation, and the rate of moisture removal.

To establish the practical significance of the observed changes, future experiments should compare untreated and pretreated pulp under identical evaporation conditions. Measurements should include evaporation duration, evaporation rate, energy consumption, final solids content, and product quality.

CONCLUSION.

The experimental investigation demonstrated a consistent decrease in the measured kinematic viscosity of tomato pulp as the treatment parameter increased from P = 1 to P = 8 for all six investigated product masses.

The relative reduction in viscosity ranged from 1.08% to 13.65%. The largest reduction was recorded at a product mass of 90, where viscosity decreased from 5.13 to 4.43. The smallest relative reduction was observed at a product mass of 40, where viscosity decreased from 10.22 to 10.11.

These results indicate that pretreatment is associated with changes in the flow characteristics of tomato pulp and that the magnitude of the response depends on the experimental conditions.

The reduction in viscosity may facilitate product circulation and mixing during subsequent concentration. Nevertheless, its effect on evaporation duration and energy efficiency must be verified through direct measurements under controlled processing conditions.

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Further research should investigate the relationship between viscosity, solids content, temperature, and treatment parameters. Such an approach will help determine whether the observed rheological changes can be used to optimize the pretreatment of tomato pulp before evaporation.

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