Mango pulp-agar based model gel: textural characterisation

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Abstract The textural properties of a model gel system have been investigated by employing an experimental design concerning the effect of agar (1–3%), mango pulp (0–50%) and sugar (0–20%). A gel characterization method, based on the principle of penetration-shearing, has been applied to determine the response functions (fracture strain, fracture stress, energy for penetration-shearing and firmness). These textural indices can be fitted well ($0.858 \leq r \leq 0.953$, $p \leq 0.01$) to second order polynomials. Agar possesses the maximum effect and an increase in agar content markedly increases these indices while sugar imparts mostly a curvilinear effect; a failure strain as high as 33% has been achieved by increasing the agar content. The individual optimization (maximization), based on canonical analysis, on these indices indicates that agar content to be more than 2.8%. Gels with extensively varying textural properties can be achieved by changing the proportions of these ingredients.

Keywords Fruit gel · Rheology · Penetration-shearing · Optimization

Introduction

Fabricated gels are important food commodities as the consumer acceptability in terms of taste, textural characteristics and appearance can be manipulated to a large extent by careful choice of hydrocolloid in addition to judicious selection of gel

forming variables (Saha and Bhattacharya 2010a). The role of rheology in this situation is critical as a liquid (sol) is transformed into a semi-solid (gel) during the process of gelling to yield products such as fruit analogues. The main purpose of developing a specialty food gel is to provide or achieve one or more specific physical properties. The desirable mechanical properties are related to storing, handling or sensory perception/properties. In some cases, the fracture properties are also important considering the consumer acceptance of the finished gelled product.

A pure aqueous model gel system involves interaction between the hydrocolloids and water, while a food gel system, being multi-component in nature, involves a complex interaction between the components (Kilara 2005). Data on the detailed textural attributes of fruit juice or pulp based gels are limited. A study on the understanding of the attributes of gels with particular reference to textural characteristics and stability of the formed gel would provide the detailed insight into this complex phenomenon that could be exploited for commercial applications.

The rheology of food gels is usually evaluated by several ways of which compression and stress relaxation studies by employing a texture measuring system (Kaletunc et al. 1990; Saha and Bhattacharya 2010b) are frequently practiced in addition to oscillation and creep testing. In practice, the large deformation properties are far more useful, and determination of the full relation between stress and strain provides better information (Walstra 2003). The material may eventually break when the deformation is increased beyond the linear elastic region. The relevant textural properties include fracture stress or strength, fracture strain or shortness, and the work of fracture or toughness. Nussinovitch et al. (1991a) have studied the effect of sugar and fruit pulp on different hydrocolloids for obtaining fruit pulp based gels. The addition of sugar

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increases the gel strength upto a certain level but decreases with further addition. Mouquet et al. (1992) are able to develop thermostable texturised alginate mango pulp gels; the concentration of alginate has been reported to be the major factor affecting mechanical properties of the texturized products.

Agar, a naturally occurring polysaccharide, is frequently used as a thickening and gelling agents in various food formulations possibly due to cost-effectiveness, easy availability, and the ability to form gel with other liquid foods such as fruit juices and pulps when cooled (Norton et al. 1999). At high temperatures, the rheological behavior of agar sol is similar to dilute dispersions of linear polymers. On the other hand, at a low temperature below the gelation point, the behavior is similar to that of cross-linked polymers. In the temperature range where the sol-gel transition occurs, the situation is further complicated. Moreover, the textural properties of agar gels depend on their thermal history (Labropoulos et al. 2002a, b). Descriptive sensory analysis and large-strain textural methods are used to evaluate textural characteristics of agar gel as a model system. Puncture testing has been employed for soybean gels (Bhattacharya and Jena 2007), and scope also exists to develop newer methods for determining the rheology of soft foods like food gels.

The objective of the present study is to determine the effects of agar, mango pulp and sugar on the textural attributes of formed fruit based gels by employing the method of penetration-shearing.

Materials and methods

Agar powder was purchased from Loba Chemie, Mumbai, India while sugar was procured from a local supermarket. Canned sweetened mango pulp (26°Brix) was purchased from Allahabad Canning Co., Allahabad, India. The pH of the pulp was between 3.8 and 3.9. The total sugar content of mango pulp was 16.4%. As per the manufacturer, agar powder contained 1% acid insoluble ash, 5% sulphated ash and 1% foreign insoluble matter.

Experimental design and data analysis

A central composite rotatable design (CCRD) of experiments was employed to determine the effect of three independent variables for gel formation such as the concentrations of agar (X_1), mango pulp (X_2) and sugar (X_3) on the four textural response functions of the formed gel (fracture strain, fracture stress, energy for penetration-shearing and firmness). The experimental ranges were 1–3% for agar, 0–50% for mango pulp and 0–20% for sugar. The design of experiments and analysis of the experimental

results were conducted by employing the response surface method (RSM) (Myers 1971; Khuri and Cornell 1989). The experimental design employed was a 3-variable, 5-level of each variable, second order design with 5 replications at the centre point (0, 0, 0) in coded levels of variables (−1.682, −1, 0, 1 and 1.682). The experimental design in the actual (X) and coded (x) levels of variables is shown in Table 1. The response functions (Y_{ijk}) were approximated by a second degree polynomial (Eq. 1) with linear, quadratic and interaction effects using the method of least squares.

$$y_{ijk} = b_0 + \sum_{i=1}^n b_i x_i + \sum_{i=1}^n \sum_{j=1}^n b_{ij} x_i x_j + \epsilon_{ijk} \quad (1)$$

$i \leq j$

The number of variables is denoted by n and j , while k and i are integers. The coefficients of the polynomials are represented by b_0 , b_i and b_{ij} , and ϵ_{ijk} is the random error; when $i < j$, b_{ij} represents the interaction effects of the variables x_i and x_j . The response surface graphs were obtained from the regression equations, keeping the response function on the Z-axis with X and Y-axes representing the two independent variables while keeping the other variable fixed at their centre point (corresponding to 0 level in coded

Table 1 Design of experiments in coded (x) and actual level (X) of variables

Experiment No.	Coded level of variables			Actual level of variables		
	Agar	Pulp	Sugar	Agar (%)	Pulp (%)	Sugar (%)
1	0	0	0	2	25	10
2	0	0	0	2	25	10
3	0	0	0	2	25	10
4	0	−1.682	0	2	0	10
5	1.682	0	0	3	25	10
6	−1.682	0	0	1	25	10
7	0	1.682	0	2	50	10
8	0	0	0	2	25	10
9	0	0	−1.682	2	25	0
10	−1	−1	1	1.41	10.14	15.95
11	1	1	−1	2.60	39.86	4.06
12	−1	1	−1	1.41	39.86	4.06
13	0	0	1.682	2	25	20
14	−1	−1	−1	1.41	10.14	4.06
15	1	1	1	2.60	39.86	15.95
16	0	0	0	2	25	10
17	1	−1	1	2.60	10.14	15.95
18	−1	1	1	1.41	39.86	15.95
19	1	−1	−1	2.60	10.14	4.06
20	0	0	0	2	25	10

level). The detailed analysis of variance (ANOVA) was conducted (in coded level of variables) including the determination of F value to know the effects of individual variables; the significance of F values was determined at $p \leq 0.10$, 0.05 and 0.01.

Preparation of texturised fruit gel

Agar powder was dispersed in requisite quantity of distilled water in a beaker with continuous stirring for 1 h at room temperature (about 25 °C). Later, the dispersion was heated in a water bath maintained at 90 °C for 1 h avoiding loss of moisture due to evaporation; sugar and mango pulp were then added in sequence to agar dispersion as per the experimental design. The well-mixed hot dispersion was then poured into plastic petriplates (10 mm in height and 47 mm in diameter) and allowed to set at room temperature for 16 h after which they were manually removed for textural measurement. The process of gel preparation was repeated twice.

Textural measurement

Texture of gel samples was determined by allowing a cylindrical ebonite probe of diameter 10 mm to pass through the gel sample i.e. penetration-shearing, a method that has been proposed in this study; Fig. 1 shows the details of the setup employed. A texture measuring system (Model TAHD, Stable Microsystems, Surrey, UK) was employed having a load cell of 50 N and the crosshead speed was 1 mm s⁻¹. The textural parameters determined from the force-deformation curves were the failure strain, failure stress, energy for penetration-shearing and firmness. The failure stress is equal to the ratio of the maximum force offered by the sample at the time of failure and the cross-sectional area of the probe during penetration-shearing. Firmness is primarily the rigidity of the material under test and was obtained from the slope of the initial linear portion

of the force-deformation curve (Szczesniak 1983). Failure strain, as evidenced by a significant decrease in force due to failure of sample, was calculated as the distance the probe had moved divided by the initial height of sample. The area under the force-deformation curve till failure was taken as the energy required for penetration-shearing. Ten samples were tested each time for textural measurement.

Optimisation

The roots (λ_1 , λ_2 , and λ_3) of the auxiliary equation ($\lambda^2 - \lambda + 1 = 0$) were calculated initially to know the nature of optimum. The response function is maximum if all the roots have negative values, and minimum if all roots have positive values. If some of the roots have positive values and some negative, then it is the situation of a saddle point meaning that the true optimum is absent in the experimental range of the variables. In the case of occurrence of saddle point, optimization was conducted by employing canonical analysis (Khuri and Cornell 1989) wherein the levels of the variables (x_1 , x_2 and x_3) were determined within the experimental range for each individual variable. This optimization method of the response functions consisted of the translation of the response function (y_k) from the origin to the stationary points (Myers 1971). Then the response function was expressed in terms of the new variables, the axes of which corresponded to the principal axes of the contour system. Optimization was conducted on coded level of variables and the results were expressed in terms of coded as well as actual level of variables.

Results and discussion

The penetration-shearing of gel samples has been performed by the set-up as shown in Fig. 1. This simple and effective attachment can be used for semi-soft solids like food gels where bending/snapping test is difficult to perform due to sagging of sample during testing. The sample force-deformation curves (Fig. 2) show a linear relationship between force offered and extent of deformation during the initial phase of testing. As the probe further penetrates the sample, non-linear deformation results. Finally, at a specific deformation, shearing of a small piece of sample occurs and it detaches from the main bulk of sample under test; at this instance, the peak force is attained. The sheared sample has a diameter close to the diameter of the penetration probe and possesses a height equal to the height of gel sample under test. It is interesting to mention here that the falling off the sample piece or the failure strain occurs much earlier the probe crosses even half the height of the gel sample. The variation in the experimental textural indices is low for penetration-

Fig. 1 Set-up employed for the penetration-shearing of gel samples

Fig. 2 Sample curves for penetration-shearing of gel samples made with (A) agar 1.4%, pulp 39.9% and sugar 4.1%, and (B) agar 2.6%, pulp 39.9% and sugar 4.1%

shearing test; the coefficient of variation (equal to standard deviation divided by arithmetic mean) is between 2.1 and 7.8%. During conventional puncture testing, compression is accompanied by shearing but does not mean complete shearing. In our suggested method, compression is accompanied by complete shearing which is the additional feature. The die-punch system of puncture testing has been mentioned by Bourne (2002).

A comparison of the Fig. 2A and B indicates that an increase in the agar concentration increases the resistive force as well as the strain at failure though both these curves exhibit a similar pattern. The coefficients of the polynomial relating the independent variables (concentrations of agar, pulp and sugar) and the response functions (failure strain, failure stress, compression energy and firmness) are shown in Table 3. A high multiple correlation coefficient (R) between 0.858 and 0.953 (significant at $p \leq 0.01$) indicates the suitability of the second order polynomials to predict the response functions.

The failure strain of the gels is between 3.1 and 33.2% (Table 2) and is a function of the independent variables. A low strain value indicates a brittle gel sample while a high value is associated with a sample that undergoes a large deformation prior to failure. The latter samples will appear

as mushy and soft if the failure stress is low, and tough and hard if failure stress is high. An increase in agar and/or pulp increases failure strain (Fig. 3) of which the former has a dominating effect (Table 3). Brittle and mushy gels result from agar while highly transparent gels are obtained when using gellan gum alone or gellan-agar system up to 1% level of hydrocolloids (Banerjee and Bhattacharya 2011). An increase in the hydrocolloid concentrations increases maximum stress and energy for compression. The linear and quadratic effects of pulp are positive and negative, respectively (significant at $p \leq 0.01$ and 0.10) meaning that a high level of pulp decreases the failure strain. Possibly a high level of pulp interferes with the process of gel formation by agar. The interaction effect of agar and pulp is also negative meaning that the decreasing effect of pulp on failure strain is dependent on the level of agar employed.

The failure stress varies widely between 13.7 and 82.2 kPa (Table 2). An increase in agar content increases the failure stress markedly as both its linear and quadratic effects are significant at $p \leq 0.01$ and 0.05, respectively. The quadratic effect of sugar is also significant at $p \leq 0.05$ meaning a curvilinear trend (Fig. 3). An increase in failure stress indicates a tougher sample and thus its integrity improves. It is obvious that agar is the hydrocolloid that produces the typical three-dimensional gel network in which sugar and pulp are entrapped. Sugar, being a highly water soluble compound, reduces the available water for gel formation and therefore the effective concentration of agar increases.

The lowest and highest values of energy for penetration-shearing are 0.3 and 11.6 mJ, respectively (Table 2). An increase in agar content increases the energy for penetration-shearing (Table 3). Though significant at $p \leq 0.10$, an increase in mango pulp also increases energy values (Fig. 3); energy also increases with sugar in a quadratic manner at $p \leq 0.05$.

The firmness or rigidity of a sample manifests the magnitude of force required to obtain a given deformation; the firmness of the gel samples varies between 0.26 and 1.30 Nmm^{-1} (Table 2). The effect of agar on firmness is highly significant ($p \leq 0.01$) while other variables play a non-significant role indicating that agar has a major role to decide the firmness attribute of the prepared gel samples (Fig. 3).

Optimisation

Table 4 shows the details of the optimization of four response functions such as fracture strain, fracture stress, penetration-shearing energy and firmness. The roots of the individual auxiliary equation are never of same magnitude indicating the absence of a true optimum condition

Table 2 Response functions based on experimental design

	Experiment No	Failure strain (%)	Failure stress (kPa)	Energy for penetration-shearing (mJ)	Firmness (N mm ⁻¹)
	1	25.64±0.77	35.64±2.05	4.92±0.38	0.60±0.04
	2	14.61±1.13	26.10±1.26	2.26±0.17	0.54±0.04
	3	20.46±1.43	20.08±0.98	2.12±0.09	0.55±0.03
	4	12.64±1.01	24.40±1.76	1.84±0.11	0.49±0.03
	5	33.20±2.09	82.18±5.59	11.55±0.84	1.30±0.10
	6	8.03±0.55	17.03±1.17	0.90±0.07	0.45±0.02
	7	22.06±0.86	32.58±2.26	4.11±0.26	0.62±0.02
	8	20.45±1.12	20.07±0.89	2.11±0.05	0.54±0.03
	9	25.87±1.56	47.77±1.79	5.69±0.34	0.55±0.02
	10	3.31±0.21	13.69±1.04	0.34±0.02	0.31±0.01
	11	25.89±1.09	48.08±2.08	6.49±0.50	0.81±0.04
	12	11.13±0.80	20.32±0.76	1.52±0.07	0.62±0.04
	13	30.15±2.13	61.01±3.44	8.37±0.46	0.75±0.02
	14	3.09±0.22	13.96±1.04	0.34±0.02	0.46±0.01
	15	31.10±1.57	55.87±2.79	7.50±0.54	1.06±0.05
	16	25.61±1.82	35.65±0.64	4.92±0.36	0.59±0.02
	17	24.82±0.97	48.23±2.46	5.46±0.39	0.26±0.01
Experimental conditions are shown in Table 1	18	24.47±0.52	22.09±1.63	2.66±0.11	0.30±0.02
Values are reported as mean ± standard deviation	19	26.26±1.43	37.68±2.04	4.33±0.32	1.00±0.06
	20	20.46±0.76	20.08±1.19	2.12±0.09	0.55±0.04

(maximization/minimization) within the range of the experimental variables studied during the present investigation. Hence, the canonical search method has been applied to find the minimum and maximum level achievable within the experimental zone.

The optimum conditions of the variables in terms of individual minimization and maximization are shown in Table 4 along with the response functions at such situations. The fracture strain needs to be high and this occurs when both agar and sugar levels are high; a high fracture strain means a delayed fracture shown by the sample during testing or eating. However, extremely high fracture strain is undesirable as eating becomes difficult and requires high energy to chew. Generally, the firmness of the sample should be good such that the sample appears to be a cohesive mass; this occurs when agar, pulp and sugar are at their high levels.

It is interesting to observe here that maximization of these four variables is associated with high levels of agar ($\geq 2.8\%$). This shows that agar simultaneously increases all these response functions to attain their highest values. At a low level of energy for penetration-shearing, the gel will behave as soggy sample without requiring adequate chewing action and may not be liked by some people; these type of gels result when agar, pulp and sugar are at their low levels. On the contrary, very high levels of energy for penetration-shearing are associated with too high level of mastication.

The formation of a gel and textural attributes of the formed gel depends on the type and concentration of the hydrocolloid used. Bayarri et al. (2002) have reported that the concentration of gellan gum has a pronounced effect on textural properties like rupture stress, rupture strain and deformability modulus. Mouquet et al. (1992) studied the texturization of pulp using alginate as the gelling agent. Significant quadratic (second order) effect of the variables has been reported for most of the response functions like compressive stress, penetration and force at failure, and thermostability. In the present study, significant quadratic effects have been observed for the concentrations of agar and sugar on failure stress for agar-mango pulp-sugar gels.

Slightly soluble calcium salts such as calcium sulphate, calcium chloride and calcium citrate have been reported to form crosslink in gels (Harding et al. 2011). The main mechanisms for gelation of hydrocolloids are the ionotropic gelation, cold-set gelation and heat-set gelation (Burey et al. 2008). Pappas et al. (1987) investigated the development and characterization of agar gels. The results from the relaxation test agree with the results obtained from the compression test. Agar and alginate have been used by Nussinovitch et al. (1991b) to develop fruit pulp based gels. Mechanical properties of agar-sugar-pulp gels are affected by changing the concentration of any of the gel components which is also true for the present study. The gel strength and deformability modulus increase with the gum concentration. The pulp seems to interfere with the dense gel matrix

Fig. 3 Response functions (failure strain: **a**, failure stress: **b**, penetration-shearing energy: **c** and firmness: **d**) as a function of independent variables

formation but contribute to its mechanical properties. It is possible that sugar probably increases the polymer intermolecular attraction but seems to cause gel inhomogeneity at high concentrations (Nussinovitch et al. 1991b). Hence, at a high concentration of sugar, the process of gel formation is affected and gels become softer.

Sugar binds the free/unbound water in the gel sample thereby lowering the syneresis in gels and this phenomenon eventually decreases the lubrication effect offered by the free/unbound water. In gels made without sugar, the free/unbound water makes the sample soft to offer a lower value of fracture stress. Similar trends have been reported by Sworn and Kasapis (1999) and Bayarri et al. (2002, 2006). These researchers reported that sucrose produces stronger gels upto a critical concentration of 40% but a progressive reduction in yield stress with near network collapse occurs at a sucrose level of 60%. In the present study, an increase in sugar concentration increases the failure stress following a quadratic pattern. It is possible that gels prepared with

fruit pulp (as in the present study) do not exhibit similar textural attributes when made only with the model system comprising a hydrocolloid alone.

It is possible that sugar and agar compete with each other for water. As water is present in the interstices of the formed gel, it comes out easily when deformed or damaged. When sugar is added, it binds with water to increase the viscosity and surface tension of the liquid present in the interstices. Thus, fracturing is delayed with simultaneous increase in strain at fracture such that the gel appears as a rigid and cohesive sample. Further, as the pulp contains a considerable amount of sugar, an increase in pulp content obviously increases the sugar level.

The effect of pulp addition on the mechanical properties of gels is also dependent on the type of pulp used. Orange pulp alone seems to have a less effect on the gel strength than banana pulp (Nussinovitch et al. 1991a). The latter seems to be able to cause the regaining of the initial gel strength when a relatively high quantity of pulp is added

Table 3 Analysis of variance (ANOVA) for response functions in coded level of variables. Independent variables: x_1 : Agar, x_2 : Mango pulp and x_3 : Sugar

Source of variation	Failure strain		Failure stress		Penetration-shearing energy		Firmness	
	Coefficient of polynomial	F value	Coefficient of polynomial	F value	Coefficient of polynomial	F value	Coefficient of polynomial	F value
Constant	21.317	—	26.680	—	3.140	—	0.568	—
Linear effect								
Agar	7.937	62.75***	16.795	43.13***	2.697	38.63***	0.210	17.85***
Pulp	3.731	13.86***	3.408	1.78 ^{NS}	0.843	3.78*	0.717	2.08 ^{NS}
Sugar	1.796	3.21 ^{NS}	3.083	1.45 ^{NS}	0.570	1.73 ^{NS}	−0.457	0.84 ^{NS}
Quadratic effect								
Agar ²	−0.903	0.86 ^{NS}	5.558	4.99**	0.697	2.72 ^{NS}	0.888	3.36*
Pulp ²	−2.057	4.45*	−1.906	0.59 ^{NS}	−0.452	1.14 ^{NS}	−0.243	0.25 ^{NS}
Sugar ²	1.711	3.08 ^{NS}	7.249	8.48**	0.982	5.40**	0.925	0.37 ^{NS}
Interaction effect								
Agar x Pulp	−2.911	4.95*	0.411	0.15 ^{NS}	0.875	0.24 ^{NS}	0.575	0.783 ^{NS}
Agar x Sugar	−1.224	0.87 ^{NS}	2.106	0.40 ^{NS}	0.125	0.49 ^{NS}	−0.250	0.15 ^{NS}
Pulp x Sugar	2.471	3.56*	−0.913	0.75 ^{NS}	0.128	0.51 ^{NS}	0.103	2.49 ^{NS}
Multiple correlation coefficient (R)	0.953***		0.927***		0.913***		0.858***	

*Significant at $p \leq 0.10$ **Significant at $p \leq 0.05$ ***Significant at $p \leq 0.01$ ^{NS} Non-significant at $p = 0.10$ **Table 4** Results of the optimisation study in coded and actual levels of variables. Independent variables: X_1/x_1 : Agar, X_2/x_2 : Mango pulp and X_3/x_3 : Sugar

Parameters			Fracture strain (Y_1)	Fracture stress (Y_2)	Compression energy (Y_3)	Firmness (Y_4)
Roots of the auxiliary equation	λ_1		2.41	7.75	1.00	0.10
	λ_2		−0.51	5.06	0.69	0.04
	λ_3		−3.15	−1.91	−0.46	−0.07
Nature of optimum			Saddle point	Saddle point	Saddle point	Saddle point
Optimum conditions in coded level of variables	x_1	Minimization	−1.68	−1.47	−1.62	−0.91
		Maximization	1.36	1.65	1.60	1.42
	x_2	Minimization	0.28	−1.68	−0.60	−1.68
		Maximization	0.78	1.23	0.50	1.68
	x_3	Minimization	−0.80	0.00	−0.22	1.63
		Maximization	1.68	−1.68	−1.68	1.34
Optimum conditions in actual level of variables	X_1	Minimization	1.00	1.12	1.04	1.46
		(%) Maximization	2.81	3.00	2.95	2.84
	X_2	Minimization	29.09	0.02	16.13	0.03
		(%) Maximization	36.64	43.33	32.39	49.99
	X_3	Minimization	5.26	9.98	8.70	19.69
		(%) Maximization	19.98	0.00	0.00	18.00
Optimum conditions of response function	Minimization		5.10	3.90	0.00	0.02
	Maximization		37.32	81.17	10.98	1.41

which may be due to high content of sugar in banana. The incorporation of particles, or fibres into matrix somewhat resembles the technique of getting a composite material with polymers. The addition of juice sacs (vesicles) tends to weaken the gel strength and deformability modulus of agar-alginate based texturized products. By entrapping the vesicles within the gel matrix, succulent products can be achieved. As mango pulp contains particulate solids as well as juice, the effect of pulp on textural attributes of gel is rather complex as particles and juice possesses contradicting effects.

Conclusions

The textural attributes of model agar-mango pulp-sugar gels have been determined employing the method of penetration-shearing of samples. The specific advantages of this method are cost-effectiveness, easy to fabricate and perform, and obtaining repeatable results. Textural attributes such as failure strain, failure stress, energy for penetration-shearing and firmness of gels have been determined by varying the proportions of agar, mango pulp and sugar. A wide range of these textural parameters has been obtained such that these gels can be termed as brittle, soggy or tough. The failure strain, ranging from 3.1 to 33.2%, is a good index to characterize these gels. The concentration of agar imparts the maximum effect on failure strain followed by the effect of pulp. Failure stress increases markedly with an increase in agar and sugar content. Fabricated food gels with varying textural attributes can be achieved by using different proportions of agar, mango pulp and sugar.

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