

Physical and sensorial characteristics of avocado spread added with different types of food hydrocolloids

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Abstract— Avocado spread is an alternative condiment for a healthy consumption due to the abundance of unsaturated fatty acids in the avocado flesh. The avocado spread mixed with food hydrocolloids (guar gum, inulin, carboxymethyl cellulose) at 3% (w/w) was studied on rheology, texture, colour and sensory evaluation in comparison with no hydrocolloid addition. For the flow analysis, all spread formulations are the non-Newtonian shear thinning fluids. Addition of food hydrocolloids increased the viscosity, oscillation stability, and heat resistance. Inclusion guar gum with the fruit spread strongly affected the hardness and work of shear. The avocado spread added with inulin showed higher greenness than the other treatments. Among the spread samples containing 3% carboxymethyl cellulose secured the highest score for spreadability, colour, flavour, taste, and overall acceptability.

Keywords—Avocado spread; food hydrocolloids; rheology and texture; colour; sensory

I. INTRODUCTION

An avocado spread is a condiment consuming with a sandwich, crackers and bread. The healthy spread is made of avocado pulp, citric acid, vinegar, salt, sugar and vanilla essence [5]. The fruit spread is good choice for consumers, who concerns on a high saturated fat and high caloric diets of traditional dressing such mayonnaise, salad dressing, prepared mustard and butter. Reducing saturated fat is the healthy image of food consumption [6]. In contrast, regular consumption of avocado flesh containing a high-monounsaturated fatty acids and polyunsaturated fatty acids, possibly relates to promoting cardiovascular health and increase the bioavailability of fat soluble and phytochemicals from the fruit [2].

Physical characteristics of the avocado spread such rheology, texture, colour are important to be the product of choice for consumers. Quality attributes in food formulations as said could be improved by food hydrocolloids as food thickeners. Hydrocolloids such carboxymethyl cellulose, inulin, guar gum has been used widely to modify the texture in soft solid foods e.g. yoghurt, mayonnaise, soup, salad dressing, topping, sauce and spread [1] [7,8].

Carboxymethyl cellulose is a modified cellulose by addition of sodiumcarboxymethyl groups to several groups of a linear glucose backbone. The thickener has a high viscosity except in a low pH condition. Guar gum is a native hydrocolloids, where the galactomannan backbone has numerous branches, thus is has a very high shear viscosity [8]. Inulin is a fructan polymer extracted from chicory and Jerusalem artichoke. It is catagorised as a soluble dietary fiber and prebiotic. For textural properties, inulin improved the

rheological behavior of yoghurt as well as enhance the growth of lactic acid bacteria [1].

The aims of this research were to study the effects of food hydrocolloids on rheological and textural characteristics, and colour of avocado spread. Sensory characteristics of the texture-modified spread samples were also compared to the original formulation.

II. MATERIALS AND METHODS

A. Materials

Food hydrocolloids, guar gum, inulin and carboxymethyl cellulose were purchased from Union Science Co. Ltd. (Chiang Mai, Thailand). The hydrocolloids used for stabiliser purpose were high-purity grade (>99%). All food ingredients used to prepare avocado spread mixture, such as condensed sweetened milk, unsweetened milk, honey, salt, pepper powder and lemonade were purchased at a local market from the Mae Rim district.

B. Processing of Avocado spread

Avocado fruits (*Persea americana* cv. Hass) was obtained from the Royal Project, Chiang Mai. The fruits were transported to the food pilot plant and graded according to commercial maturity and defects. The avocado fruits with a standard size, 250-300 g were used in the following procedure. Whole fruits were washed with clean water and allowed to drain. The fruits were manually cut in a half and scooped the flesh of the avocado out of its peel. The flesh was cut into 1 cm cubes. A typical mixture of avocado spread is given in Table 1.

Table 1 Formulation for Avocado spread

Ingredients	Formulation (%)	Amount (g)
Avocado flesh	46.40	200
condensed sweetened milk	13.92	60
unsweetened milk	12.33	54
honey	12.99	56
salt	2.78	12
pepper powder	0.44	1
lemonade	11.14	48

Initially hydrocolloids (3% w/w) were dissolved in a half portion of unsweetened milk. Avocado flesh was blended with the portion of the milk for 30s in a Kitchen Aid mixer. Then all other ingredients (sweetened milk, honey, pepper powder, salt and lemonade) were slowly added alternating with hydrocolloid-unsweetened milk mixture. The quality of final formulations was controlled at pH at 4.1, moisture 50% dry basis. Finally, the avocado spread was kept in a closed plastic cup and allowed the spread to set aside for two hours before physical measurements and sensory evaluation.

C. Rheological measurements

Rheological measurements were carried out by using a rheometer (Anton-Paar's MCR302, Austria). The parallel plate geometry (50 mm diameter, PP50/TG) and a Peltier-temperature-controlled hood were connected to the rheometer. The geometry was pressed on spread samples with a 1 mm gap to study both flow mode for apparent viscosity (Pa.s) and oscillation mode for observations strain, frequency, and temperature effects. All measurements were carried out in triplicate.

Steady-shear rheology of spread samples was obtained from different shear rate values ranging from 0 up to 100s^{-1} at ambient condition. The changes in apparent viscosity (Pa.s) were recorded as a function of the moving shear rate values.

Dynamic-shear rheology was determined by oscillatory measurements. For a strain sweep test at an ambient condition, an amplitude was swept from 0.01% up to 100% at a fixed frequency at 0.1 rad/s. Then, a frequency sweep between 0.01-100 rad/s was carried out within the linear viscoelastic domain at 0.5% strain for each sample. The temperature ramp was further observed the heat stability in a wide range of temperatures (15-65°C). The elastic or storage (G') and the viscous or loss (G'') moduli were determined as a function of strain, frequency, and temperature.

D. Textural measurements

Textural properties of avocado spread were examined using a texture analyser (TA.XT plus, Stable Micro System, UK). The hardness and shear work were obtained by penetration mode at 27°C. The accessories included conical probe with 60° cone angle (P/60C) and a heavy duty platform (HDP/90) using a 25 kg load cell. Each sample was placed into the plastic container and pressed down in order to avoid air bubbles. Any excess of the sample was scraped off with a

sharp knife. The container was put on the platform and the conical probe was penetrated into the sample surface with a 20 mm depth. The conditions for penetration test were pre-test speed (20 mm/s), test speed (1 mm/s), and post-test speed (10 mm/s). Results were expressed as an average of five measurements.

E. Syneresis by centrifugal measurements

Serum separation of avocado spread was obtained by modifying the centrifugal method of Hassan et al (2015) [3]. Ten milliliter of spread at 27°C was slowly transferred to 50 ml plastic centrifugal tube. The centrifugal tubes were adjusted to the balanced weights and centrifuged at 2400 rpm/min. in a Hettich centrifuge (Universal, USA) for 10 min. The quantity of serum at the top of the sample inside the tubes was weighted and expressed as an index of syneresis (weight of supernatant / weight of spread sample x 100). The high volume of the supernatant, the high syneresis and vice versa.

F. Colour measurements

Surface colour of the spread was evaluated using a colourimeter (Minolta colourimeter CR-400) at room temperature (27°C). Colour was expressed in CIE L* (brightness), -a* (greenness) and +b*(yellowness). Five replicate measurements were performed and reported results in average numbers.

G. Sensory evaluation

Sensory studies were conducted after two-hour storage at room condition (27°C). Sensory criteria, including spreadability, colour, flavor, taste, and overall acceptability were evaluated by 30 untrained panelists of a 9-point hedonic scale rating from 1 (dislike the most) to 9 (like the most).

H. Statistical analysis

The data were presented as the mean±standard deviation (SD). The experimental data were statistically analysed by Completely Randomised Design (CRD) for texture and colour measurements and for Randomised Complete Block Design (RCBD) for sensory score. The effects of hydrocolloids addition on the texture, colour, and sensory perception were evaluated using analysis of variance (ANOVA), and mean values were compared using Duncan's multiple range test ($p<0.05$). All statistical analysis was performed using an IBM SPSS version 23 (IBM, USA) and a microcomputer.

III. RESULTS AND DISCUSSION

A. Rheological characteristics

Rheology is a science of dealing with liquid and soft solid flow and deformation as affected by stress, strain, frequency temperature and time. This typically includes two modes of measurements, flow mode and oscillation mode. The first mode traditionally determines the apparent viscosity using a rotational viscometer or a rheometer. Viscosity profiles of avocado spread with various types of hydrocolloids are shown in Fig.1.

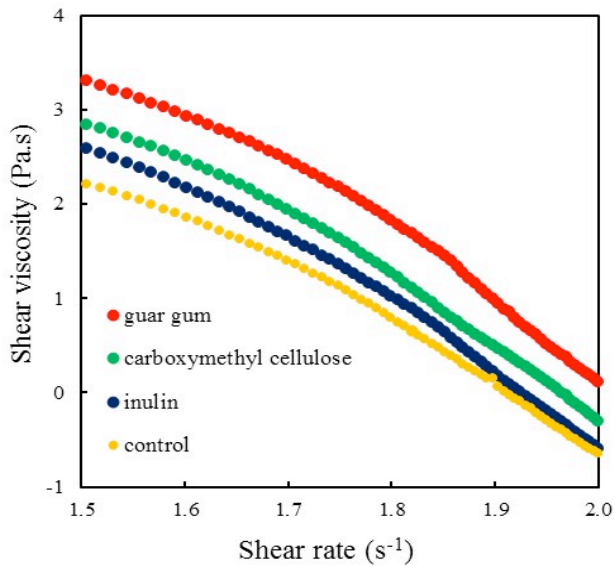


Fig.1 Changes in shear viscosity values of avocado spread with different types of hydrocolloids as a function of shear rate

Avocado spread showed non-Newtonian shear thinning behavior, where the flow characteristic is a contrary relationship between a shear viscosity and a shear rate. The addition of hydrocolloids in the spread systems increased the apparent viscosity values. The highest viscosity of avocado spread was observed in guar gum inclusion due to a greater branches in the gum structure to hydrate and bind with water molecules [9].

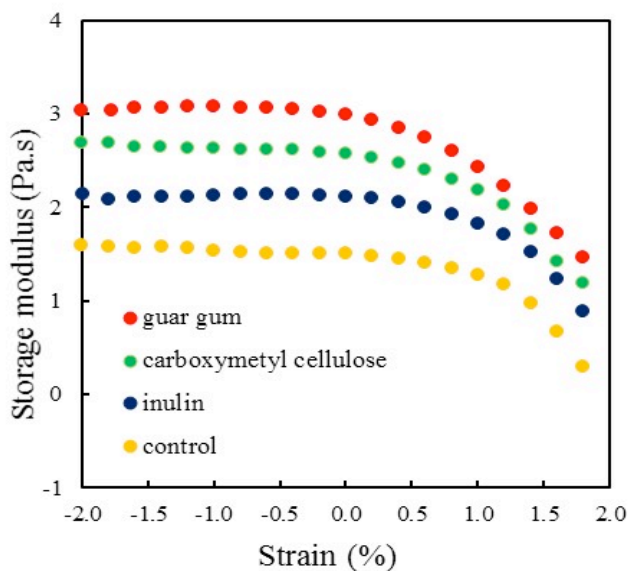


Fig.2 Strain amplitude sweep of avocado spread with different types of hydrocolloids as a function of strain at a constant frequency (0.1 rad/s)

Dynamic oscillatory shear rheological properties of avocado spread was investigated at different strain levels. The viscoelastic behaviour of the spread was independent of strain up to a critical strain level, where the storage modulus values were declined. The addition of hydrocolloids positively affected the network association within the spread mixtures. Critical strain for all spread systems was stabilised about 0.5%.

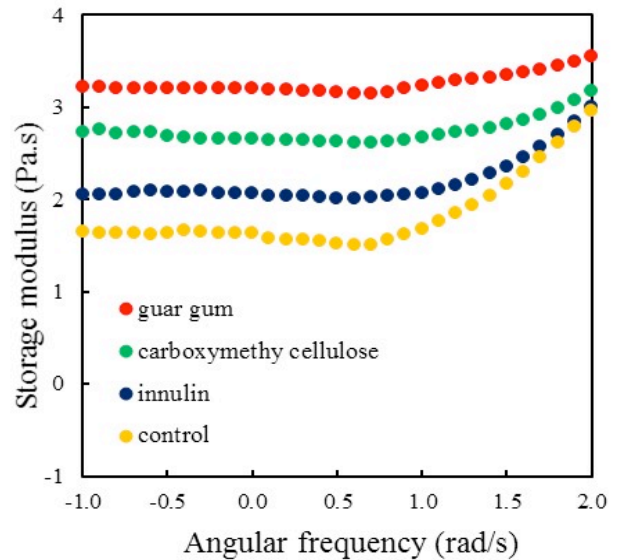


Fig.3 Frequency sweep of avocado spread with different types of hydrocolloids as a function of angular frequency at a constant 0.5% strain

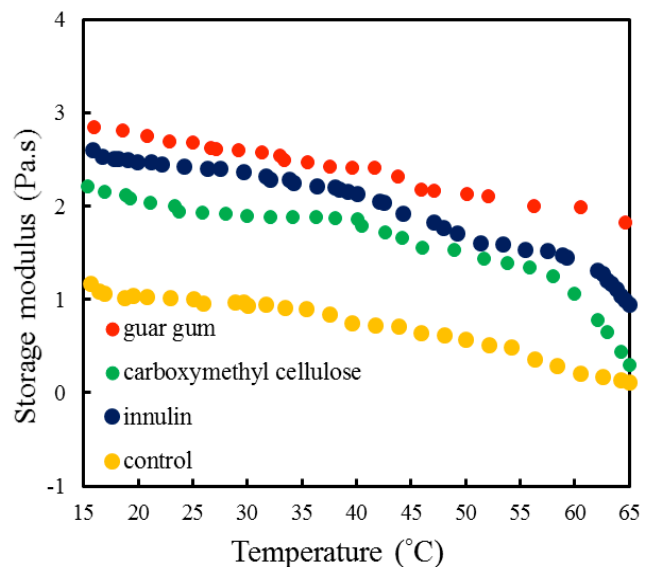


Fig.4 Temperature sweep of avocado spread with different types of hydrocolloids as a function of temperature (fixed 0.5% strain and frequency at 0.1 rad/s)

According to Fig. 3, a frequency sweep could be further characterised in a wide range of oscillation frequencies at a constant strain (0.5%) and temperature (27°C). The storage modulus, G' is nearly stable under a low frequency applied to the samples as could be expected for a solid-like behavior. Conversely, the higher frequencies disturbed on the network stability, thus the spread became progressively more fluid-like. Formation of a stronger network in avocado spread mixed with guar gum enhanced the network complex to persist the high frequency variation.

The thermal stability of avocado spread is an important characteristic to explain microstructure and the interaction of fluid droplets against separation. Effects of heat on spread melting was considerably observed in Fig.4, where the temperature raised up to 40°C. The lost in solid-like state was seen in the avocado spread without any hydrocolloids.

B. Textural characteristics and syneresis

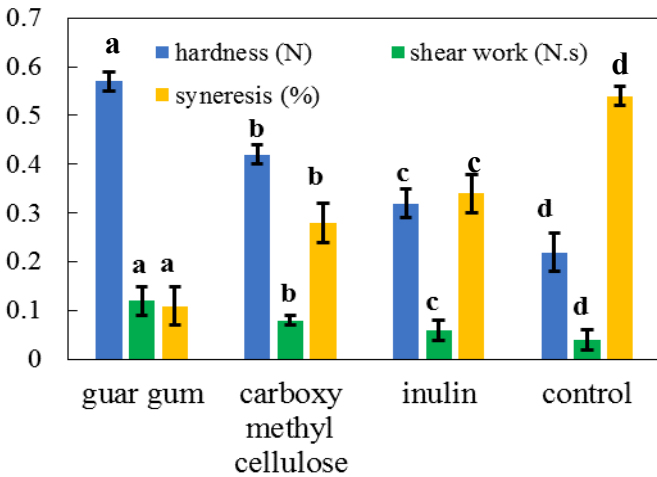


Fig.5 Textural characteristics and syneresis of avocado spread with different types of hydrocolloids

Textural properties of spread samples were analysed using a texture analyser to determine hardness and shear work depending on different hydrocolloids (Fig. 5). An original spread formulation had the lowest textural values, comparing three samples with hydrocolloids added. Avocado spread in the presence of guar gum showed a lowest syneresis effect due to a highly stable gel. A viscous water phase in gum matrix decreased phase separation between water and oil phase [4].

C. Colour characteristics

Table 2 Colour of avocado spread with different types of hydrocolloids

Avocado spread	Brightness (L*) Ns	Greenness (-a*) Ns	Yellowness (+b*)
Guar gum	65.71±0.41	-3.11±0.03	36.98±0.41 ^a
Caboxy cellulose	65.03±0.73	-3.05±0.53	34.23±0.48 ^b
Inulin	64.89±0.28	-3.42±0.26	33.94±0.22 ^b
Control	65.75±0.72	-3.20±0.07	32.11±0.12 ^c

Mean±standard deviation (n=5)

Means (a-c) with a column followed by different letter are significantly different at (p<0.05)

Ns No statistical different



guar gum carboxymethyl cellulose inulin control

Fig. 6 Colour of avocado spread added with three types of food hydrocolloids

Colour characteristics of avocado spread were comparatively investigated as shown in Table2. The brightness and greenness values of all formulations were statistically insignificant different. However, the spread with hydrocolloids added were appearing more shiny and yellowness-surface as seen in Fig. 6. The increase in yellowness of the spreads was a result of the original colour of hydrocolloids added, e.g. guar gum powder was light yellow tan.

D. Sensorial characteristics

Table 3 sensory scores of avocado spread with different types of hydrocolloids

Avocado spread	Guar gum	Caboxy cellulose	Inulin	Control
Spreadability	4.53±5.80 ^b	5.80±0.71 ^a	5.67±0.55 ^a	5.60±0.81 ^a
Colour	4.87±0.78 ^c	6.63±0.96 ^a	5.97±0.67 ^b	5.93±0.78 ^b
Flavor	4.63±0.85 ^c	5.93±0.69 ^a	5.67±0.76 ^a	5.40±0.67 ^b
Taste	4.77±0.73 ^c	6.47±0.97 ^a	5.90±0.66 ^b	5.83±0.83 ^b
Overall acceptability	3.97±0.96 ^c	5.73±0.78 ^a	5.23±0.50 ^b	5.30±0.47 ^b

Mean±standard deviation (n=30)

Means (a-c) with a row followed by different letter are significantly different at (p<0.05)

Organoleptic evaluation are generally the most important test for consumer's perception on the modified-texture soft-solid foods such as mayonnaise, spread, ketchup, and yoghurt [10]. Overall, avocado spread with carboxymethyl cellulose showed the highest scores in all attributes, see Table 3. Addition of guar gum at a high level (3%) strongly affected the textural and rheological properties, that inversely related to spreadability and mouthfeel.

IV. CONCLUSIONS

Several food hydrocolloids were added in avocado spread in order to deliver a physical and sensorial characteristics for the consumer. The hydrocolloids are included in the spread system to principally adjust rheology and texture. Hydrocolloids can be used in avocado spread production to increase cream stability and adjust the apparent viscosity during transportation and storage at relatively high

temperature. However, the selection of hydrocolloids in the spread depended on organoleptic quantity and acceptability.

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REFERENCES

- [1] Abdelmoneium, A. H., Sherif, A. M., and Sameh, K. (2016). Rheological properties of yoghurt manufactured by using different type of hydrocolloids. *Austin Journal of Nutrition and Food Science*. 4, 1082.
- [2] Dreher, M. and Davenport, A. J. (2013). Hass avocado composition and potential health effects. *Critical Reviews in Food Science and Nutrition*. 53, 738-750.
- [3] Hassan L. K., Haggag H. F., El Kalyoubi M. H., EL-Aziz M. A., El-Sayed M. M., Sayed A. F. (2015). Physico-chemical properties of yoghurt containing cress seed mucilage or guar gum. *Annals of Agricultural Science*. 60, 21-8.
- [4] Mudgil, D., Barak, S., and Khatkar, B. S. (2014). Guar gum: processing properties and food applications- A Review. *Journal of Food Science and Technology*. 51, 409-418.
- [5] Ofasu, I. W., Owusu, A. A., Mensah, W. A., Oldham, J. H., and Oduro, I. (2011). Modeling the formulation and shelf life of avocado (*Persea americana*) fruit spread. *American Journal of Food Technology*. 6, 661-673.
- [6] Paisley, C., Lloyd, H., Spinks, P., and Mela, D. J. (1995). Consumer perceptions of dietary changes for reducing fat intake. *Nutrition Research*. 15, 1755-1766.
- [7] Puliguadla, P., Cho, Y., Lee, Y. (2015). Physicochemical and sensory properties of reduced fat mayonnaise formulations prepared with rice starch and starch-gum mixtures. *Emirates Journal of Food and Agriculture*. 27, 463-468.
- [8] Saha, D. and Bhattacharya, S. (2010). Hydrocolloids as thickening and gelling agents in food: a critical review. *Journal of Food Science and Technology*. 47, 587-597.
- [9] Sanchez, V. F., Bartholomai, G. B., and Pilosaf, A. (1995). Rheological properties of food gums as related to their water binding capacity and to soy protein interaction. *LWT-Food Science and Technology*. 28, 380-385.
- [10] Sharoba, A. M., Senge, B., Elmansy, H. A., Bahlol, H., and Blochwitz, R. (2005). Chemical, sensory, and rheological properties of some commercial German and Egyptian tomato ketchups. *European Food Research and Technology*. 220, 142-151.