

Effect of Granular Size and Physical Properties on the Sensory Distinction of Hardness and Size of Meat Grains

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Samples of heated ground meat with differing water content (approximately 44-66%) and granular size (approximately 2-9 mm) were prepared for sensory distinction tests on hardness and size, and the sensory scores were examined in relation to the water content, granular size, and hardness measured with an instrument.

Different hardness could be distinguished between two samples with the same granular size when the water content differed by 5-9%. Based on the water content, the Weber ratio for hardness distinction ranged from 0.16 to 0.08 and was negatively correlated with the granular size. Based on the hardness measured with an instrument, the Weber ratio for hardness distinction ranged from 0.58 to 0.20 for samples with a high water content, and it ranged from 0.16 to 0.08 for samples with a low water content. Both values were negatively correlated with the granular size.

Different size could be distinguished between two samples with the same water content but differing in size by a factor of approximately 1.51 for all the sample pairs. When the two samples differed in size by a factor of approximately 1.23, the limit for size distinction depended on the water content of the samples, which ranged from approximately 56 to 65%. The samples with a large granular size needed a high water content for size distinction; for those samples at the limit of size distinction, the hardness measured with an instrument was within a constant range regardless of the granular size.

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INTRODUCTION

Ground meat dishes were introduced to provide an effective use for meat off-cuts, but they are now considered quite respectable menu items. The meat patty is the most popular ground meat dish. As well as the taste and odor, texture is an important factor for the tastiness of meat patties.

Wani *et al.* (1982) have reported that the characteristics of the meat grains in a patty (granular size and distribution) were important for objectively expressing the texture of meat patties, and that these characteristics were highly correlated with the ultimate fracture strength or with the coefficient of viscosity evaluated by the compressive punch method. Izutsu *et al.* (1980) have shown that the most important sensory factors in the texture of a meat patty were the geometrical characteristics according to the classification by Szczesniak (1963), and particularly "nikuryukan" (the size and amount of

meat-like granules) which is expressed by the required cutting energy with a knife. The authors (Imai *et al.* 1994) have previously prepared meat patty samples from ground meat of differing granular size, and examined the effect of granular size on the physical properties and sensory distinction of the samples. The results of sensory tests indicated that the "juiciness" and strength of "umami" were not influenced by the granular size, but that the rheological properties, including "nikuryukan," did depend on the granular size. The effect of the granular size was in the order of beef > pork > chicken and was further investigated by measuring the granular size of the meat grains and the physical properties of the resulting meat patties. However, it is still necessary to examine the degree of distinction of granular size for ground meat itself, in which the meat grains are not adhering, unlike the case with meat patties.

In regard to the size distinction of food particles, the authors have recently examined the relationship

between the degree of particle size distinction and the physical properties for particles of less than 500 μm in size (Imai *et al.* 1998, 1999), but no studies were made on large grains.

In this present study, samples of heated ground meat were used to clarify the degree of sensory distinction of the hardness and size of meat grains, and to investigate the granular size of meat grains and the hardness measured with an instrument in relation to their size and hardness perceived in the mouth.

MATERIALS AND METHODS

Materials

Internal and external ham was taken from pigs with an average body weight of 103 kg that had been bred for 190 days at the Hanamaki Kanegasaki Stock Farm (Kanegasaki, Tanzawa, Iwate Prefecture, Japan), was cut into pieces after 3 days of ripening, and then minced 3 days after. The fat in the pork was partially removed while being cut into pieces, and the remaining fat and sinews were removed when being minced.

Preparation of the samples

The meat was minced with a meat grinder (Career Kogyo, GM-DX model), using plates with orifices of 3.4 or 6.8 mm in diameter. The meat temperature was 3–4°C before and 4–5°C after grinding, and all the grinding conditions selected were the most suitable. Approximately 300 g of the ground meat was put in individual freezer backs (Japan Saniback, 160×220×0.07 mm) and immediately placed in an air-draught freezer (–35°C internal temperature and 5 m/s air velocity) to quick-freeze the ground meat down to –30°C. Each ground meat back took 21–24 min to completely freeze, and the frozen backs were stored in a freezer at –30°C.

Before preparing each sample, the frozen ground meat was thawed for about 20 h in the chilling compartment (0±2°C) of a refrigerator. Table 1 shows the general composition of the ground meat.

The thawed ground meat (150 or 300 g) was put into an elliptical mold (21 cm in diameter) on a hot plate (Toshiba HGT 20 B) at 140 or 160°C, and was stirred with two pairs of long chopsticks at the rate of 70 times/min to unbind the meat grains.

The heating period varied from 2 to 15 min to prepare ground meat with a water content of approximately 45–65%. The cooked ground meat was passed through nine types of standard sieve (JIS 2, 2.36, 2.8, 3.35, 4, 4.75, 5.6, 6.7 and 8 mm) to obtain

Table 1. Approximate composition of the meat

Composition	(%)
Water ^a	74.4
Protein ^b	21.4
Lipid ^c	2.1
Ash ^d	1.1

^a Heat-drying method at 135°C under normal pressure. ^b Micro-Kjeldahl method. ^c Bright-Dyer method. ^d Direct mineralization method.

eight types of sample with different granular size (A–H in order of the grain size). About 200 samples were prepared from the combination of eight types of granular size and 45–65% of water content.

Measurement of the granular size

A color-image analytical processing device (Mitani Shoji IMC-512V8; SPECTRUM system) was used to measure the equivalent area diameter (the diameter of a circle with the same cross-sectional area), the degree of circularity ($4\pi \times \text{area} / (\text{circumferential length})^2$; 1 for a circle), the maximum length, and the lengths of the long axis and short axis, assuming an elliptical form, for about 100 grains of each sample which had been photographed.

Measurement of the water content

Samples A–H (5 g each) were dried for 2 h by the heat-drying method at 135±2°C under normal pressure according to the JAS analytical tests. The percentage water content was calculated as (original weight – weight after drying) / original weight] × 100.

Measurement of the hardness

A sample (1.2±0.05 g) was placed evenly in a rice cup (24 mm in diameter and 6 mm in depth), and the hardness was measured with a texturometer (Zenken, lucite plunger of 18 mm dia. with 1.5 mm clearance) by the method used for plant proteins (Okabe 1977). The value measured in this way is referred to as hardness *M*.

Sensory evaluation

A sample of approximately 1.2 g on a spoon covered with a paper cup was served to each panelist. The panelist removed the paper cup without taking a look at the sample and put it into the mouth.

The distinction test for the hardness and size of a sample was according to the paired comparison method. A pair of samples (X and Y) were served to a panelist, who put the X sample into the mouth, examined the size with the tongue and the upper jaw without chewing, and then examined the hardness with the back teeth while chewing. After the

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evaluation, the sample was swallowed or spat out and the mouth rinsed well. Next, the panelist put the Y sample into the mouth and evaluated the size and hardness in the same way. The panelist was instructed to circle one of three alternatives for evaluating the size (X is bigger, Y is bigger, or X and Y have the same size) and the hardness (X is harder, Y is harder, or X and Y have the same hardness).

The two samples were served in the same right-and-left position to half of the panelists, and then in the opposite right-and-left position to the other half of the panelists. The sensory evaluations were conducted in individual compartments in a sensory evaluation room under red light from 10:00 to 11:00 A.M. and from 2:00 to 4:00 P.M. The panelists were 20 members of the Cookery Science Laboratory of Ochanomizu University ranging in age from 21 to 24.

The data from the evaluation test with the right answer were treated by the binomial test (one-sided test) for the number of people who gave the right answer. The answer "X and Y are the same" was considered as the wrong answer. The data from the evaluation test without the right answer were treated by the *t*-test (the test for the average by a pair of samples) for evaluating the difference in the number of the answers.

The value perceived in the mouth is referred to as hardness *S*.

RESULTS AND DISCUSSION

Granular size of the samples

Table 2 shows the average value for the granular size of each sample. The volume was calculated from measurements of the long axis and short axis of an ellipse.

Each sample was spindle-shaped, and the two-dimensional degree of circularity ranged from 0.79 to 0.87. Samples A-C were more spherical than samples D-H. The size of each sample was 2.13-9.18 mm in

equivalent area diameter, 2.79-11.4 mm in maximum length, and 4.06-334 mm³ in elliptical volume. The ratio of granular length between A and B, B and C, C and D, D and E, E and F, F and G, and G and H was 1.23 ± 0.07 . The wide range of granular size was used for the experiments. The granular size of a sample is expressed by the equivalent area diameter in this study.

Relationship between the water content of a sample and hardness *M*

Figure 1 shows the relationship between the water content and hardness *M* of the samples for each granular size. For any granular size, hardness *M* increased with decreasing water content. The water content and hardness *M* were highly correlated.

The range of hardness *M* depended on the granular size. For example, hardness *M* of the samples with a water content of 44-66% ranged from 7 to 3 kgf for sample A, and ranged from 10 to 6 kgf for sample H. In other words, for samples with the same water content, hardness *M* depended on the granular size and increased with increasing granular size.

Distinction of hardness *S*

1. Hardness *S* distinction between two samples with the same granular size, but differing in water content

A sensory evaluation was conducted to determine the smallest possible difference in water content of two samples with the same granular size which allowed hardness *S* distinction. The sensory evaluation was conducted on samples with both high and low water contents. For the sample pairs with a high water content, a sample with a water content of approximately 66% was paired with another sample with a water content of (66-0 to 10)%. For the sample pairs with a low water content, a sample with a water content of approximately 44% was paired with another sample with a water content of (44+0 to 10)%. The results are shown in Fig. 2.

Table 2. Granular sizes of the samples

	Sample							
	A	B	C	D	E	F	G	H
DC ^a	0.87	0.86	0.85	0.81	0.79	0.79	0.81	0.81
ED ^b	2.13	2.66	3.33	4.59	5.48	6.63	7.69	9.18
MD ^c	2.79	3.43	4.25	6.00	7.16	8.40	9.64	11.4
VE ^d	4.06	8.02	15.8	39.9	67.7	124	194	334

^a Degree of circularity ($4\pi \times \text{area} / \text{circumference}^2$). ^b Equivalent area diameter ($2 \times \sqrt{\text{area} / \pi}$; mm). ^c Maximum diameter (mm). ^d Volume of ellipsoid (mm³).

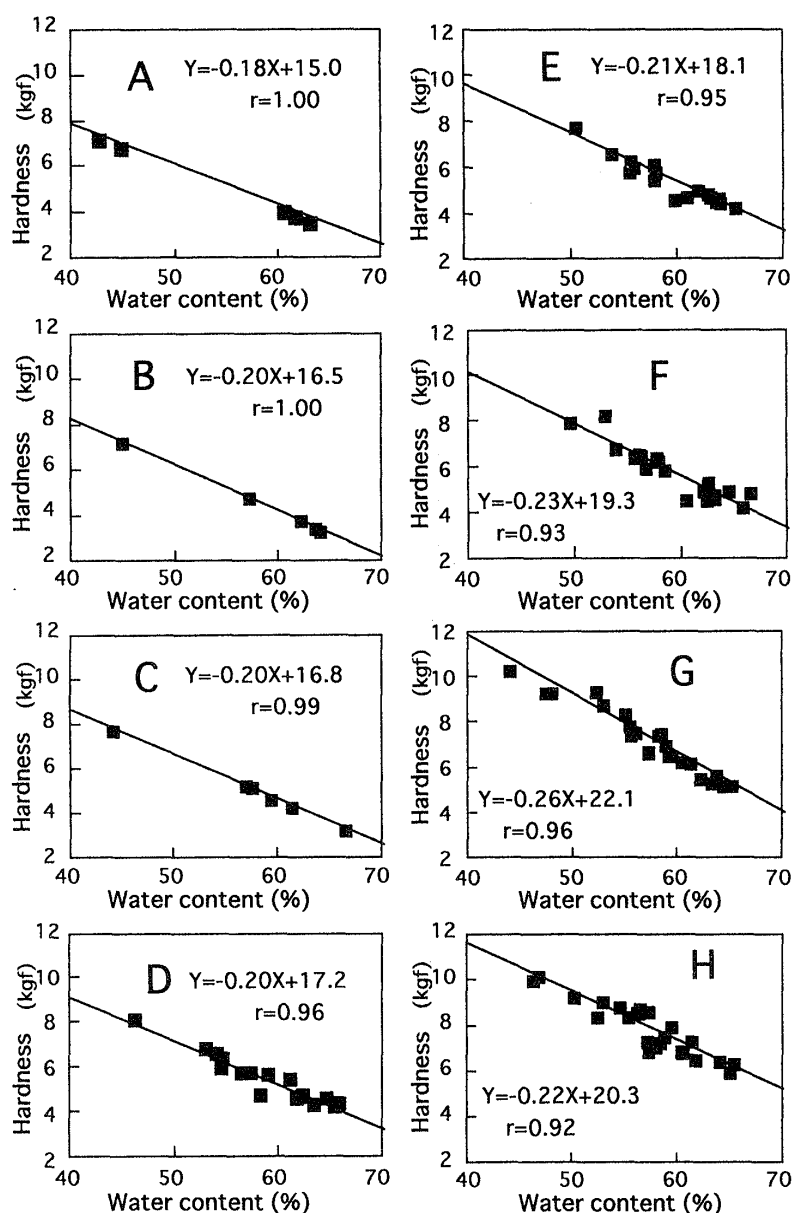


Fig. 1. Relationship between the water content and hardness M of the samples for each granular size

A-H: cf. Table 2.

For sample A with a high water content, hardness S was not distinguishable between the samples with water contents of 64.7 and 56.3% (8.4% difference) but was distinguishable between the samples with water contents of 65.3 and 56.0% (9.3% difference). The difference in water content necessary for hardness S distinction was within the range from 8.4 to 9.3% for sample A with a high water content. For sample H with a high water content, however, hardness S was not distinguishable between two samples with a water content difference of 5.4%, but

was distinguishable between two samples with water content difference of 5.9%. The difference in water content necessary for hardness S distinction was within the range from 5.4 to 5.9% for sample H with a high water content. For hardness S distinction between two samples (one with a water content of approximately 66% and another sample), the necessary difference in water content decreased with increasing granular size.

For sample A with a low water content, the difference in water content necessary for hardness S

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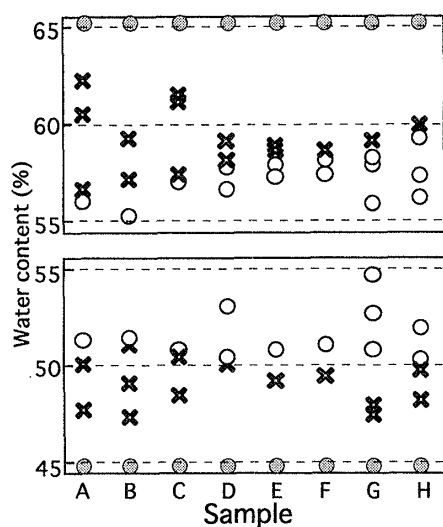


Fig. 2. Sensory distinguishability of hardness between paired samples with the same granular size and different water content

○, distinguished a hardness difference between the sample and a sample with a water content of approximately 66% ● (upper figure), and between the sample and a sample with a water content of approximately 44% ● (lower figure). ×, could not distinguish a hardness difference between the sample and a sample with a water content of approximately 66% ● (upper figure), and between the sample and a sample with a water content of approximately 44% ● (lower figure). A-H: cf. Table 2.

distinction was within the range from 5.5 to 7.0%, which is 2-3% lower than that for the samples with a high water content. Samples B-H with a low water content also showed values 2-3% lower than those for the samples with a high water content. For hardness *S* distinction between two samples (one with a water content of approximately 44% and another sample), the necessary difference in water content decreased with increasing granular size.

The data from the sensory evaluation were used to determine the Weber ratio ($\Delta I/I$) for the hardness distinction of heated ground meat. The Weber ratio was determined from the water content and from hardness *M*, which was calculated by substituting the water content in the regression equation obtained from Fig. 1. The value for ΔI was the difference in water content or hardness *M* between the sample pairs whose hardness difference was distinguishable or not. The value for *I* was the accurate water content or hardness *M* of the sample with a water content of approximately 66 or 44% for the samples with high or low water content. Consequently, the value for ΔI of

the samples with a high water content was the low limit of the threshold value for hardness distinction, while the value for ΔI of the samples with a low water content was the upper limit of the threshold value for hardness distinction. Figure 3 shows the Weber ratio plotted against the logarithm of the granular size for samples A-H.

The Weber ratio based on the water content (left in Fig. 3) ranged from 0.16 to 0.08 for the samples with high and low water contents. The Weber ratio decreased with increasing granular size ($p < 0.001$ and $p < 0.01$ for the samples with high and low water contents, respectively). If the granular size was the same, the Weber ratio based on the water content was almost constant and was independent of the water content. The Weber ratio was, thus, correlated with the granular size and could be expressed by the following equation for samples with both high and low water contents:

$$\text{Weber ratio} = -0.03 \times \ln(\text{granular size}) + 0.16 \\ r = 0.79 \quad (p < 0.001).$$

The Weber ratio was similar to or smaller than that based on taste at a moderate concentration (Sato 1991; Tasaki and Ogawa 1989).

The Weber ratio based on hardness *M* (right in Fig. 3) ranged from 0.58 to 0.20 for the samples with a high water content and ranged from 0.18 to 0.08 for the samples with a low water content. The Weber ratio decreased with increasing granular size for the samples with both high and low water contents ($p < 0.001$ for both). The samples with a low water content had a similar Weber ratio to that based on the water content mentioned in the previous paragraph. The samples with a high water content, however, gave a Weber ratio based on hardness *M* that was higher than that based on the water content. When the Weber ratio for the hardness *S* distinction was determined from the hardness measured by the texturometer, the value depended on hardness *M* for the value of *I*. It has been recognized that the Weber ratio for several senses was constant within a moderate range of stimulus, but increased when the stimulus was strong or weak (Sato 1991), which applies well to the Weber ratio based on the hardness measured with the texturometer.

- Hardness *S* distinction between two samples with the same water content, but differing in granular size by a factor of approximately 1.23, i.e., between A and B, B and C, C and D, D and E, E and F, F and G, and G and H

A sensory evaluation was conducted to examine the

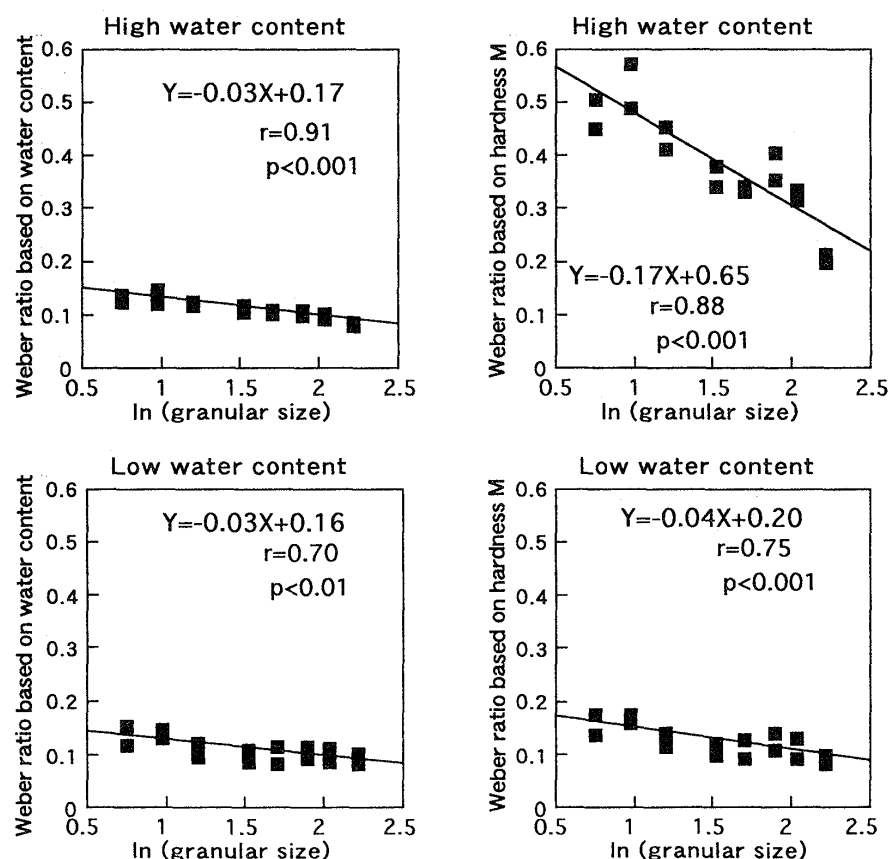


Fig. 3. Relationship between the granular size and the Weber ratio (left, based on water content; right, based on hardness M) for the sensory distinguishability of hardness

hardness S distinction between two samples with the same water content, but differing in size by a factor of approximately 1.23. The results are shown in Table 3.

The sensory evaluation was repeated 5–10 times for each sample pair, which resulted in 45 sensory evaluation tests. For each sample pair, the percentages of people who answered “Both samples had the same hardness,” “The sample with larger granular size was harder” and “The sample with smaller granular size was harder” were determined.

With all the sample pairs, 52.4% (on average) of people answered that “Both samples had the same hardness.” Twenty-seven point four percent (on average) of people answered that “The sample with larger granular size was harder,” and 20.2% (on average) of people answered that “The sample with smaller granular size was harder.” The percentages were significantly different ($p < 0.001$) from each other by the t -test. Only with pair E-F was the percentage of “The sample with smaller granular size was harder” slightly higher than that of “The sample with larger granular size was harder.”

Table 3. Hardness S distinction between paired samples with the same water content and different granular size

Sample	n	Panelists who distinguished hardness difference (%)		
		Same ^a	L ^b	S ^c
A:B	5	55.0	25.0	20.0
B:C	6	54.2	28.3	17.5
C:D	5	55.0	27.0	18.0
D:E	6	52.5	30.8	16.7
E:F	5	49.0	25.0	26.0
F:G	8	50.6	27.5	21.9
G:H	10	50.5	28.5	21.0
Average		52.4 ^l	27.4 ^m	20.2 ⁿ

^a Both samples had the same hardness. ^b The larger granular-size sample was harder. ^c The smaller granular-size sample was harder. ^{l-m} Means in the same row with different letters are significantly different at $p < 0.001$.

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As is shown in Fig. 1, the hardness measured with the texturometer increased with increasing granular size when the water content was constant. Consequently, it may be natural that people would tend to feel that "The sample with larger granular size was harder." This aspect was next investigated. The Weber ratio for the sensory hardness distinction based on hardness M is shown on the right side of Fig. 3. Hardness S of two samples is not distinguishable if the Weber ratio of the samples is smaller than the Weber ratio in the graphs. With 45 pairs in this experiment, hardness M was calculated from the water content of each sample by using the appropriate regression equation in Fig. 1. Hardness M was used to determine the Weber ratio of the paired samples, which was compared with the values in Fig. 3. Although Fig. 3 shows the Weber ratio in comparison only with the sample with a water content of either approximately 66 or 44%, it was presumed that hardness S was not distinguishable between the 45 pairs.

Among the 45 pairs of samples with different granular size, the difference in size was distinguished in some pairs but not in others, which will be described in the next paragraph. It was examined whether or not hardness S distinction was influenced by the distinguishability of the granular size. The percentages of answers "Both samples had the same hardness," "The sample with larger granular size was harder," and "The sample with smaller granular size was harder" were 51.7, 27.5 and 20.8%, respectively, for the pairs whose granular size could be distinguished. The equivalent percentages were 54.0, 25.7 and 20.3% for the pairs whose granular size could not be distinguished. When the percentages for each answer were treated by a test of the ratio difference (Tsuji and Arima 1991) between the pairs whose size difference was distinguishable and not distinguishable, there was no significant difference. Hardness S distinction was thus shown to be independent of size distinction.

For the sample pairs whose hardness was not thought to be distinguishable, about half of the panel could not distinguish the hardness difference. About 27% of the panel felt that the sample with larger granular size was harder, which was significantly higher than the percentage of people who felt that the sample with smaller granular size was harder.

Distinction of the granular size**1. Granular size distinction between samples with the same water content**

A size distinction test was conducted on two samples with almost the same water content but differing in granular size in order to investigate the smallest possible difference in granular size which could be sensorily distinguished. As a result of the sensory evaluation, size distinction was possible with any sample pair differing in granular size by more than a factor of approximately 1.51, which included pairs A-C and B-D. With two sample pairs differing in granular size by a factor of approximately 1.23, however, the size distinguishability depended on the water content (Fig. 4); for pair A-B, for instance, size difference was distinguishable when the water content was less than approximately 56%, but was not distinguishable when the water content was more than 59%. The water content necessary for size distinction tended to increase with increasing granular size of the pair; with pair G-H, size difference was distinguishable between the samples with a water content of less than approximately 65%.

It was found that the granular size difference was generally distinguishable for heated ground meat when two samples differed in granular size by a factor of approximately 1.51. For certain granular-size pairs, the size difference was distinguishable by a factor of approximately 1.23. In other words, size difference

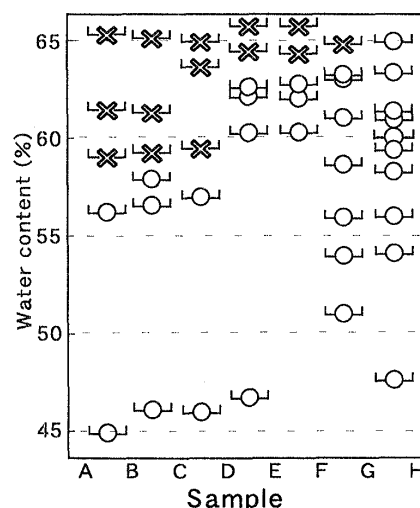


Fig. 4. Distinguishability of granular size difference between paired samples with the same water content and different granular size

○, distinguished a size difference between paired samples.
×, could not distinguish a size difference between paired samples. A-H: cf. Table 2.

was distinguishable with a Weber ratio of 0.23 in some cases, which conforms with the results of previous studies on the size distinction of food particles less than $500\mu\text{m}$ in size (Imai *et al.* 1998, 1999).

The water content of samples and their hardness measured with a texturometer were examined to investigate the granular size range in which size distinction was impossible between two samples differing in size by approximately 1.23 times. Figure 5 shows the relationship between the granular size and the accurately measured water content of each sample for pairs, and the relationship between the granular size and hardness M calculated for a known water content from the regression equation in Fig. 1.

The water content at the limit of size distinguishability was positively correlated with the granular size, and the water content increased with increasing granular size (see the left side of Fig. 5, $p < 0.001$). On the other hand, no correlation was apparent between hardness M and the granular size (see the right side of Fig. 5). Hardness M of all the samples in this experiment was in the approximate range from 3 to 11 kgf as is shown in Fig. 1. Limiting hardness M for sensory size distinction between samples differing in size by 1.23 times, however, was found to be in the range from 4.2 to 6 kgf, regardless of the granular size under the conditions used in this experiment. As has been described in the previous paragraph, two samples with the same water content differing in granular size by approximately 1.23 were sensed to have the same hardness. There has also been a report (Szczesniak *et al.* 1963) of the hardness measured with a texturometer being highly correlated with the sensory hardness. It is suggested that the size distinction between two samples differing in granular size depended not on the size of the grains,

but on their sensory hardness and on their hardness measured with a texturometer.

2. Size distinction between samples of the same granular size differing in water content

The results from the previous paragraph that the size distinction of the grains depended on their hardness encouraged us to conduct a size distinction test on two samples with the same granular size but differing in water content, *i.e.*, differing in hardness, which may have caused a difference in the perception of size in the mouth. Table 4 shows the results of this sensory evaluation.

With 5–9 pairs of each granular size, a total of 56 pairs were subjected to the sensory evaluation. The difference in water content between the two samples ranged from 2.6 to 9.9%. The percentages of the panel who answered that “The samples had the same size,” “The sample with lower water content was larger” and “The sample with higher water content was larger” were determined for all sample pairs. While the results of the size distinction tests varied with the granular size, there was no significant trend. For any granular size, 53.3% (on average, 44–63%) of the panel answered that the two samples had the same size, 27.7% (on average) of the panel answered that the sample with lower water content was larger, and 18.9% (on average) of the panel answered that the sample with higher water content was larger. There was a significant difference ($p < 0.001$) among the percentages for the three answers.

Size distinction was examined in relation to the hardness distinguishability between the paired samples. The 56 pairs were divided into two groups based on their hardness distinguishability. The group in which the hardness was distinguished gave a percentage ratio of the panel who answered “The samples

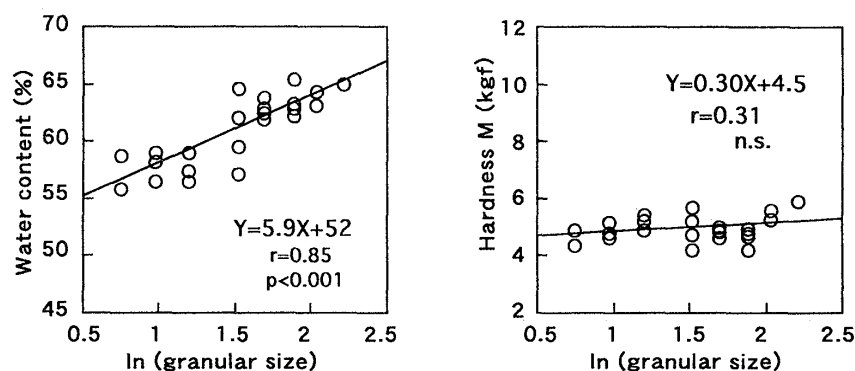


Fig. 5. Relationship between the granular size and Water content (left), and the hardness M (right) for the distinguishability of granular size difference

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Table 4. Size distinction between paired samples with the same granular size and different water content

Sample	n	Panelists who distinguished size difference (%)		
		Same ^a	L ^b	S ^c
A:A	7	62.9	21.4	15.7
B:B	7	57.2	25.7	17.1
C:C	7	58.6	27.1	14.3
D:D	7	50.7	31.4	17.9
E:E	6	44.2	29.2	26.7
F:F	5	57.0	26.0	17.0
G:G	9	47.8	28.9	23.3
H:H	8	53.1	27.5	19.4
Average		53.3 ^l	27.7 ^m	18.9 ⁿ

^aBoth samples had the same size. ^bThe lower water-content sample was larger. ^cThe higher water-content sample was larger. ^{l-m}Means in the same row with different letters are significantly different at $p < 0.001$.

had the same size": "The sample with lower water content was larger": "The sample with higher water content was larger" of 53.0%: 28.0%: 19.0%. The group in which the hardness was not distinguished gave an equivalent ratio of 54.4%: 26.6%: 19.0%. The percentages for each answer were not significantly different between the two groups, which indicates that the hardness distinction between the paired sample had no influence on the size distinction.

It was also examined whether or not the size distinction was influenced by the water content of the paired samples. The percentages for the three answers described in the previous paragraph were in the ratio 55.7%: 25.7%: 18.7% and 51.5%: 29.0%: 19.4% for the groups with high and low water contents, respectively. The percentages for each answer were not significantly different between the two groups, which indicates that the difference in water content of the pair had no influence on the size distinction.

Therefore, about half of the panel felt that the two samples with the same granular size had the same size, even if they differed in water content. A little less than 28% of the panel felt that the sample with lower water content, *i.e.*, the harder sample (including those whose hardness was sensorily indistinguishable) had larger granular size. This latter percentage was significantly higher than that of the panel who felt that the sample with higher water content, *i.e.*, the softer sample, was larger in granular size.

In the foregoing granular size distinction 1, the size distinction was found to be related to the physical properties of the grains. In addition, in the granular size distinction 2, the perception of size difference was found to be influenced by the physical properties of grains, even if the grains were the same size.

CONCLUSION

Heated meat grain samples with differing water content (approximately 44–66%) and granular size (eight types with an equivalent area diameter ranging from 2.1 to 9.2 mm) were used to examine the hardness and size distinction between the samples. The effects of physical properties of the grains on the hardness and size distinction were also investigated. The results were as follows:

1. Hardness distinction was investigated between the samples with different water content and the same granular size. The Weber ratio for the hardness distinction was 0.16–0.08 (based on water content), which was negatively correlated with the granular size of a sample. For samples with the same water content, a significantly higher percentage of panelists felt that the sample with large grains was harder than of those who felt that the sample with small grains was harder. Hardness perception was found to be involved with the granular size.

2. Size distinction was investigated between samples with different granular size and the same water content. The Weber ratio for the size distinction was around 0.23, which was involved with both the water content and granular size of a sample. For samples with the same granular size, a significantly higher percentage of panelists felt that the sample with low water content was harder than of those who felt that the sample with high water content was harder. Size perception was found to be influenced by the water content, or the physical property of a sample.

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肉粒の硬さと大きさの識別に及ぼす粒度と物性の影響

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水分含量 (約 44~66%) および粒度 (約 2~9 mm) の異なる加熱挽き肉試料を調製し, 硬さおよび大きさの識別試験を行い, 水分含量, 機器測定 of 硬さおよび粒度との関係を検討した. 粒度が同じ試料間では, 硬さの識別は水分含量 5~9% 以上の差で可能となった. 硬さ識別のウエーバー比は, 水分含量を基準とすると 0.16~0.08 の範囲にあり, 粒度と負の相関関係があった. また, それは機器による硬さを基準にすると水分含量の高い試料群では 0.58~0.20 と大きかったが, 水分含量の低い試料群は 0.16~0.08 であり, 両者とも粒度と負の相関関係があった. 水分含量が同じで粒度のみ異なる試料間の大きさの識別は, 粒度が約 1.51 倍異なる場合はすべて可能であった. 約 1.23 倍異なる場合は識別可否の境が試料の水分含量約 56~65% の範囲にあり, 粒度が大きいほど境の所の水分含量は大きかった. この境に位置する試料の機器による硬さと粒度の関係を検討したところ, 機器による硬さは粒度に関係なくある一定の範囲にあった.

キーワード: 官能評価, 挽き肉, 粒度の弁別, 硬さ測定, ウエーバー比.