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Supplementary materials

Varietal differences in sweetness value and flesh juiciness among persimmon cultivars

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All relevant data are within the paper and its Supporting Information files.

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The authors declare no competing interests.

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Key words: breeding stock, *Diospyros kaki* Thunb., flesh juiciness, sweetness value.

Abstract: To promote persimmon breeding project, we analyzed the sugar composition (a ratio of sucrose to hexose sugars, SH ratio) and flesh juiciness of 43 persimmon cultivars (*Diospyros kaki* Thunb.) consisting of 24 pollination-constant non-astringent (PCNA)-types and 19 non-PCNA-types, together with other fruit quality traits. The cultivar collection includes newly-released cultivars after 1990 and commercially-produced local cultivars in Japan. These cultivars were broadly classified into three types: sucrose accumulators, intermediate accumulators, hexose accumulators. Analysis of variance showed that the genotypic effect on the SH ratio and flesh juiciness is high with negligibly small environmental variance, indicating that SH ratio and flesh juiciness can be determined by a one-year trial without tree replication. Highly varietal diversity in the SH ratio and flesh juiciness was observed within and between persimmon cultivar types. Sweetness value (SSC × SH ratio) of the cultivars/selections seems to be a useful predictor of fruit sweetness. In terms of palatability, however, persimmon cultivar's improvement should be performed on the sweetness value in association with flesh juiciness.

Table S1 - List of reference value based on the cultivation record of Japanese persimmon preserved in Fukuoka Agricultural and Forestry Research Center from 2008 to 2015

Cultivar/Selection	Fruit ripening time (Day - month)	Fruit size (g)	General shape	Transverse diameter (mm)	Longitudinal diameter (mm)	Fruit shape index (FSI)	Skin color (apex. CC)	Cracking apex	Cracking of calyx-end	Number of seed	Soluble solids content (°Brix)
PCNA											
Early-Oct.											
Soushu	5-Oct	277	flat	87.5	57.9	0.66	7.5	0.7	0.5	2.0	14.5
Mid-Oct.											
Izu	20-Oct	248	flat	84.9	58,0	0.68	6.5	0.2	1.1	2.5	15.2
Shinshuu	20-Oct	287	relatively flat	85.4	67.5	0.79	5.4	0.5	1.2	5.0	17.1
Late-Oct.											
Sodawase	22-Oct	422	relatively oblong	95.5	82.8	0.87	5.3	0.3	0.0	4.8	17.9
Reigyoku	25-Oct	291	relatively flat	87.8	64.8	0.74	5.8	0.3	0.1	3.4	16.8
Taiga	25-Oct	326	flat	93.8	63.0	0.67	5.3	0.3	0.2	3.8	16.6
Kanshu	26-Oct	248	relatively flat	82,0	64.5	0.79	5.9	0.1	0.0	3.9	16.3
Kishu	26-Oct	308	flat	89.9	61.7	0.69	5.9	0.2	0.3	4.5	14.7
Taishu	27-Oct	412	relatively flat	97.7	71.4	0.73	4.7	0.3	1.2	1.7	15.7
Maekawajiro	28-Oct	334	flat	92.6	62.1	0.67	5.8	1.8	0.5	2.1	16.5
Tenjingosho	28-Oct	289	relatively oblong	85.4	68.6	0.80	6.6	0.0	1.2	1.3	17.2
Early-Nov.											
Akiou	3-Nov	374	flat	96.4	60.1	0.62	5.9	0.4	1.1	0.1	17.6
Misatogosho	4-Nov	345	relatively flat	89.8	70.8	0.79	5.7	1.3	0.6	3.6	18.1
Uenishiwase	4-Nov	288	relatively flat	89.7	64.5	0.72	5.1	0.1	1.6	2.3	15.9
Matsumotowase-Fuyu	4-Nov	278	relatively flat	87.8	62.5	0.71	5.6	0.0	0.7	3.4	15.4
Mid-Nov.											
Mushirodagosho	16-Nov	420	relatively flat	100.1	73.7	0.74	5.8	0.0	0.1	3.5	14.4
Youhou	16-Nov	336	relatively flat	93.5	65.9	0.70	6.8	0.3	1.3	2.0	17.0
Late-Nov.											
Fuyu	24-Nov	320	relatively flat	90.6	66.3	0.73	6.5	0.1	0.7	4.3	16.4
Okitsu-20 (Ro-19)	24-Nov	312	relatively flat	89.5	68.3	0.76	5.9	0.0	0.3	4.4	19.6
Taiho	24-Nov	291	relatively flat	86.9	65.9	0.76	5.5	0.1	0.1	2.5	17.1
Early-Dec.											
Okugosho	5-Dec	266	relatively flat	86.7	61.6	0.71	7.3	2.9	1.3	5.3	18.3
Suruga	5-Dec	249	relatively flat	83.5	65.3	0.78	5.9	0.3	1.7	4.1	17.5
Hanagosho	10-Dec	263	relatively flat	84.1	65.9	0.78	4.5	0.4	0.4	2.0	17.1
PVNA											
Late-Sept.											
Nishimurawase	30-Sep	200	relatively flat	78.5	55.0	0.70	5.4	0.0	0.0	4.0	15.1
Early-Oct.											
Akagaki	6-Oct	222	relatively flat	78.2	59.7	0.76	6.2	0.0	0.0	5.2	16.0
Mid-Oct.											
Fudegaki	19-Oct	125	Oblong	54.4	81.6	1.50	6.3	0.1	0.0	5.1	16.3
Ganzan	19-Oct	204	Circular	72.9	65.3	0.90	4.1	0.0	0.0	6.4	15.3
Oomiyawase	19-Oct	194	Oblong	71.9	73.4	1.03	4.3	0.0	0.0	5.1	16.9
Saefuji	19-Oct	233	Oblong	70.7	86.6	1.22	5.8	0.0	0.0	5.1	17.3
Late-Oct.											
Rendaiji	30-Oct	220	relatively flat	80.6	59.9	0.74	4.6	0.0	0.0	0.0	14.8
Early-Nov.											
Zenjimaru	10-Nov	205	relatively oblong	76.2	61.6	0.81	5.8	1.8	0.4	5.1	17.6
Early-Dec.											
Shogatsu	10-Dec	377	relatively oblong	94.3	77.2	0.82	4.2	0.0	0.2	5.6	17.4

Fruit ripening time (*Late-Sep., Early- to Late-Oct., Early- to Late-Nov., Early-Dec.*) was classified according to Yamada *et al*. (1995).
Fruit skin color was visually measured based on a color chart for Japanese persimmon.
FSI= Longitudinal diameter/transverse diameter of fruit (see Fig. 5S).
Cracking of apex: 1 (absent or weak), 2 (moderate), 3 (strong) according to UPOV (2004).
Cracking of calyx-end: 1 (absent or weak), 2 (moderate), 3 (strong) according to UPOV (2004).
Cultivation trial of Akiou was performed from 2011 to 2015.

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Cultivar/Selection	Fruit ripening time (Day - month)	Fruit size (g)	General shape	Transverse diameter (mm)	Longitudinal diameter (mm)	Fruit shape index (FSI)	Skin color (apex. CC)	Cracking apex	Cracking of calyx-end	Number of seed	Soluble solids content (°Brix)
PVA											
Mid-Oct.											
Tonewase	15-Oct	283	flat	88.5	59.0	0.67	5.2	0.0	0.0	0.1	15.2
Early-Nov.											
Hiratanenashi	2-Nov	276	relatively flat	87.0	60.6	0.70	4.6	0.0	0.0	0.0	16.9
Koshuhyakume	2-Nov	384	Oblong	92.7	94.4	1.02	6.7	0.0	0.0	2.3	17.3
Taigetsu	10-Nov	418	relatively oblong	94.0	79.4	0.84	5.4	0.0	0.5	3.9	15.6
Taiten	10-Nov	461	flat	104.6	71.1	0.68	4.9	0.3	0.2	3.0	16.9
Mid-Nov.											
Aizumishirazu	20-Nov	236	relatively flat	80.9	62.8	0.78	5.2	0,0	0.0	0.0	14.9
PCA											
Mid-Oct.											
Ichidagaki	15-Oct	148	Circular	64.6	63.9	0.99	5.2	0.0	0.0	4.7	19.7
Late-Oct.											
Saijo	25-Oct	234	Oblong	71.9	76.4	1.06	4.2	0.0	0.0	3.3	16.4
Kawazokogaki	30-Oct	283	relatively oblong	82.7	70.6	0.85	4.7	0.0	0.0	3.0	16.2
Early-Nov.											
Hagakushi	10-Nov	209	Circular	77.5	70.9	0.91	5.5	0.0	0.0	4.3	17.6
Mid-Nov.											
Atago	25-Nov	251	Oblong	72.3	90.7	1.25	4.9	0.0	0.0	1.3	15.8

Fruit ripening time (*Late-Sep., Early- to Late-Oct., Early- to Late-Nov., Early-Dec.*) was classified according to Yamada *et al*. (1995).
Fruit skin color was visually measured based on a color chart for Japanese persimmon.
FSI= Longitudinal diameter/transverse diameter of fruit (see Fig. 5S).
Cracking of apex: 1 (absent or weak), 2 (moderate), 3 (strong) according to UPOV (2004).
Cracking of calyx-end: 1 (absent or weak), 2 (moderate), 3 (strong) according to UPOV (2004).
Cultivation trial of Akiou was performed from 2011 to 2015.

Table S2 - Analysis of variance (ANOVA) for sugar composition of pollination-constant non-astringent (PCNA) type in Japanese persimmon among three years (b) using four genotypes (a) with three trees (c) per genotype and eight fruits (d) per tree

Source of variation	df	Espected mean square
Genotype	a - 1	$\sigma^2 + d\ \sigma t\ y^2 + bd\ \sigma t^2 + bcd\ \sigma g^2$
Year	b - 1	$\sigma^2 + d\ \sigma t\ y^2 + acd\ \sigma y^2$
Genotype x year	(a - 1) (b - 1)	$\sigma^2 + d\ \sigma t\ y^2 + cd\ \sigma gy^2$
Among trees within genotype	(ac - 1) - (a - 1)	$\sigma^2 + d\ \sigma t\ y2 + bd\ \sigma t^2$
Tree x year	(ac - 1) (b - 1) - (a - 1) (b - 1)	$\sigma^2 + d\ \sigma t\ y^2$
Among fruit within tree	abc (d - 1)	σ^2

ANOVA was performed by a fixed model (Asakuma and Shiraishi, 2017).

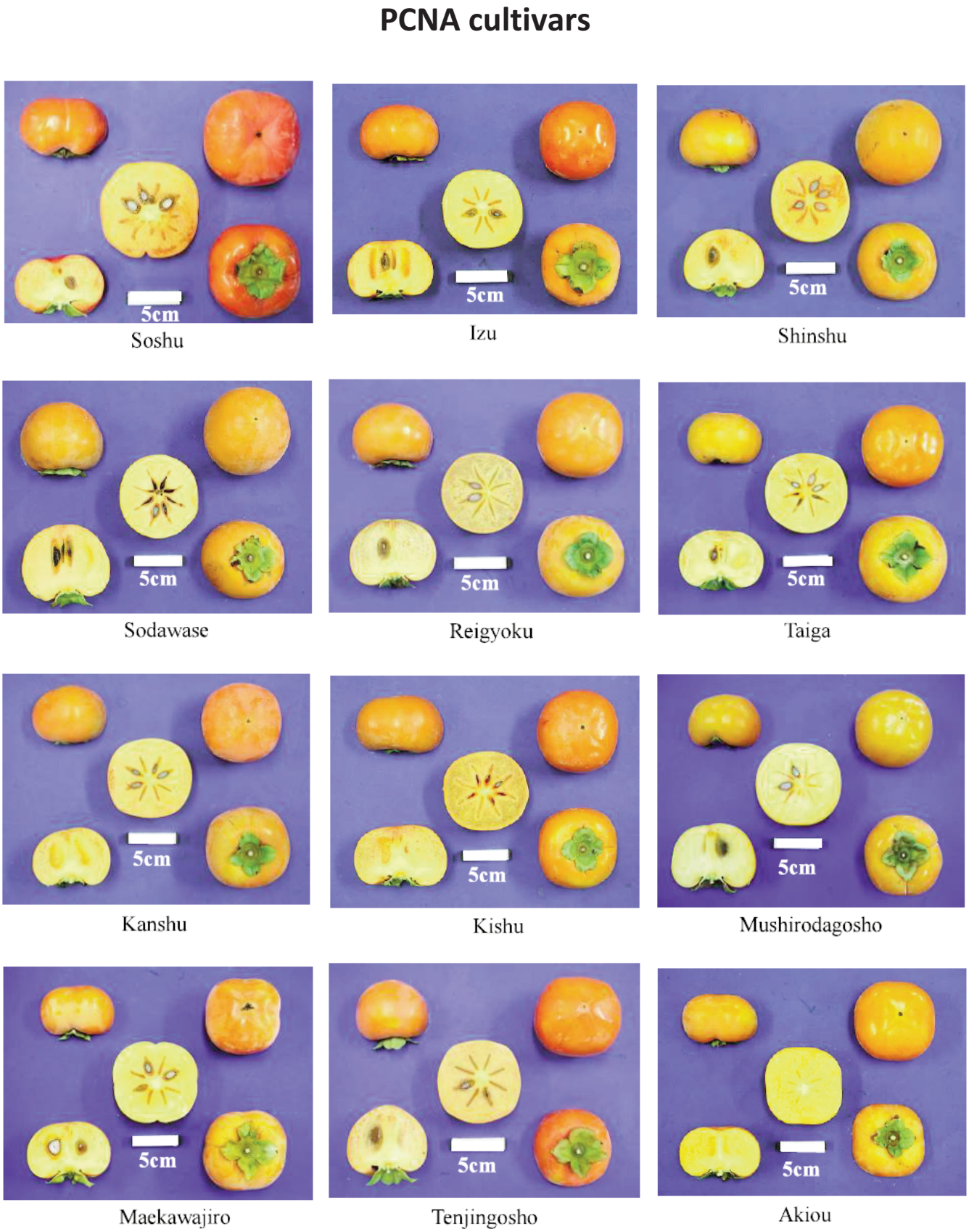
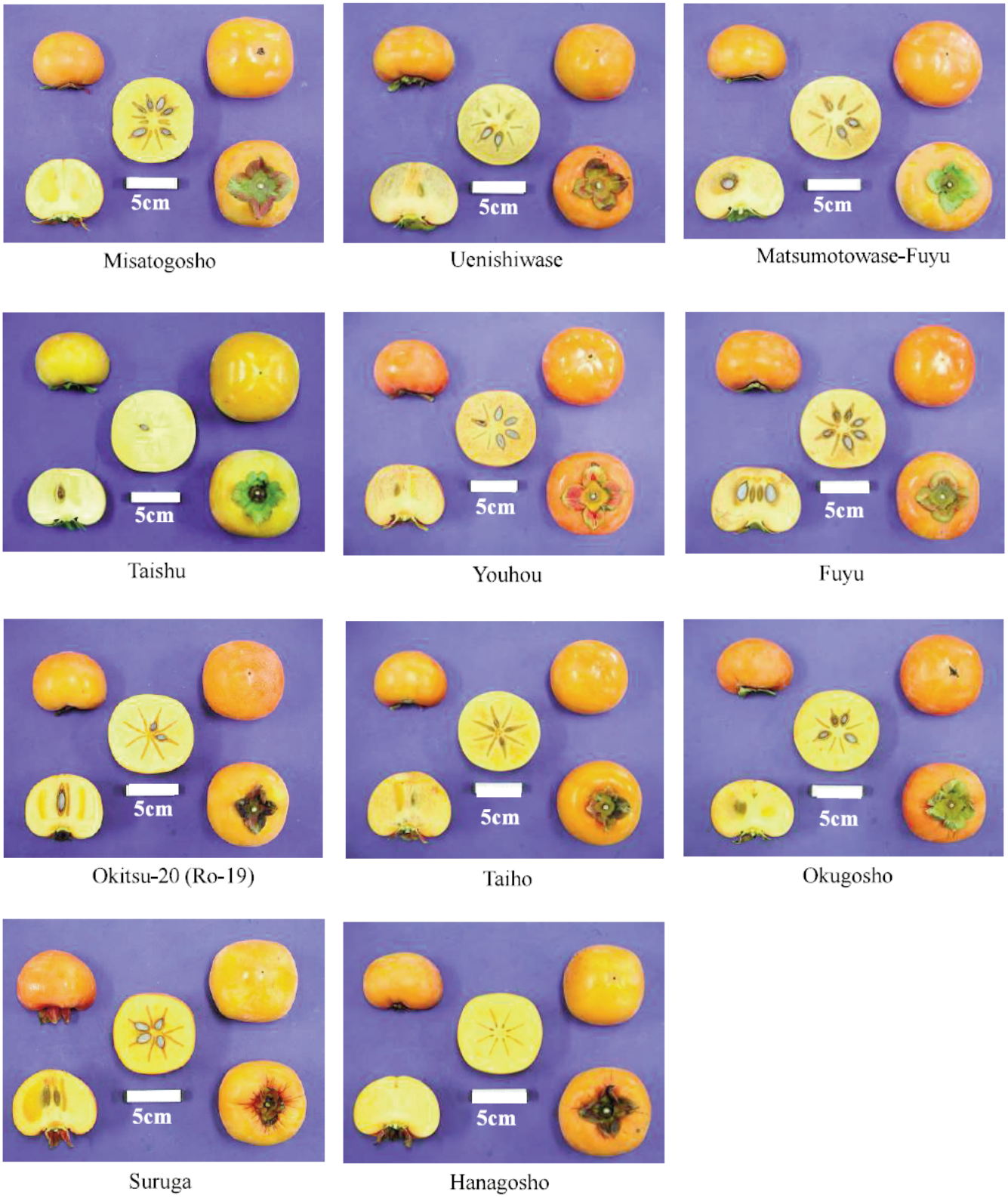


Fig. S1 - Japanese Persimmon cultivars pollination-constant non astringent (PCNA) type.

PCNA cultivars



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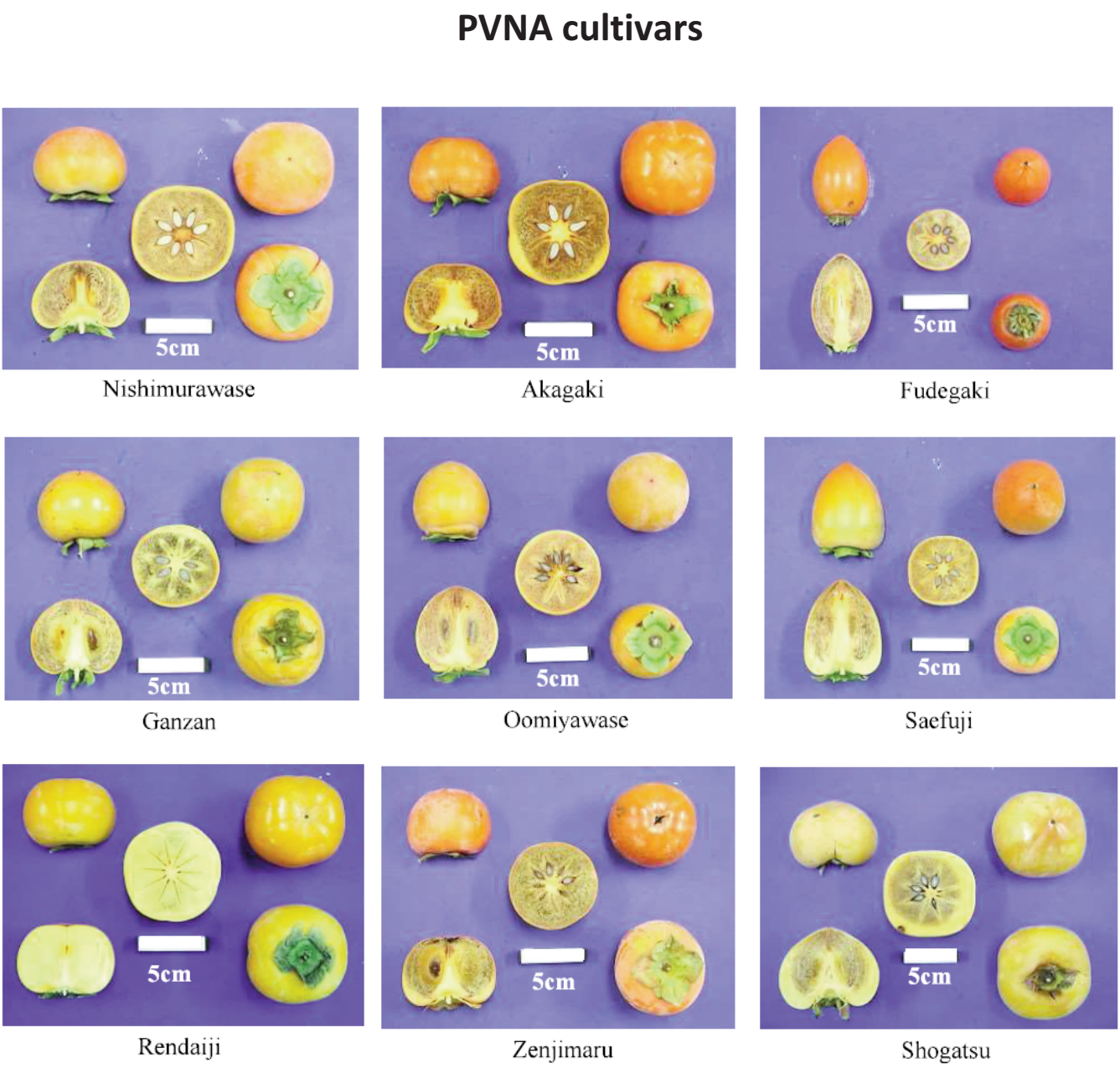

Fig. S2 - Japanese Persimmon cultivars pollination-variant non astringent (PVNA) type.

PVA cultivars

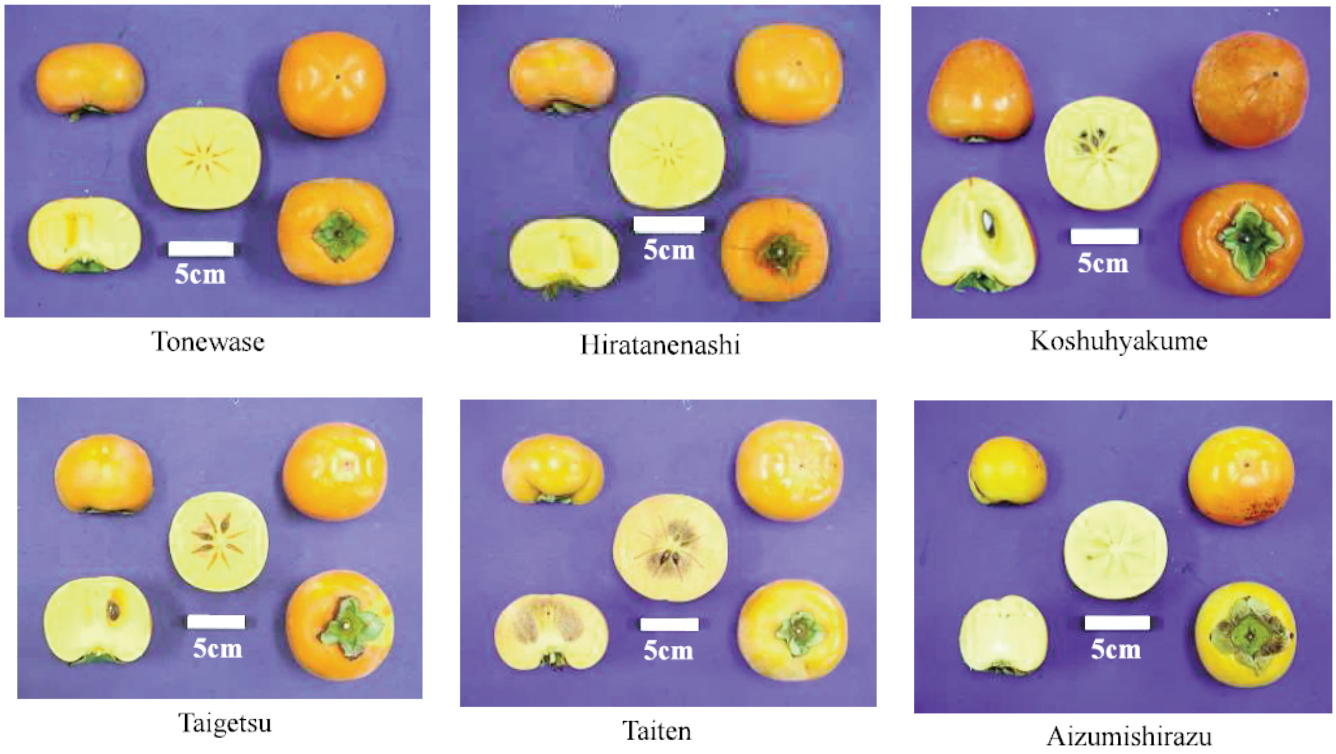

Fig. S3 - Japanese Persimmon cultivars pollination-variant astringent (PVA) type.

PCA cultivars

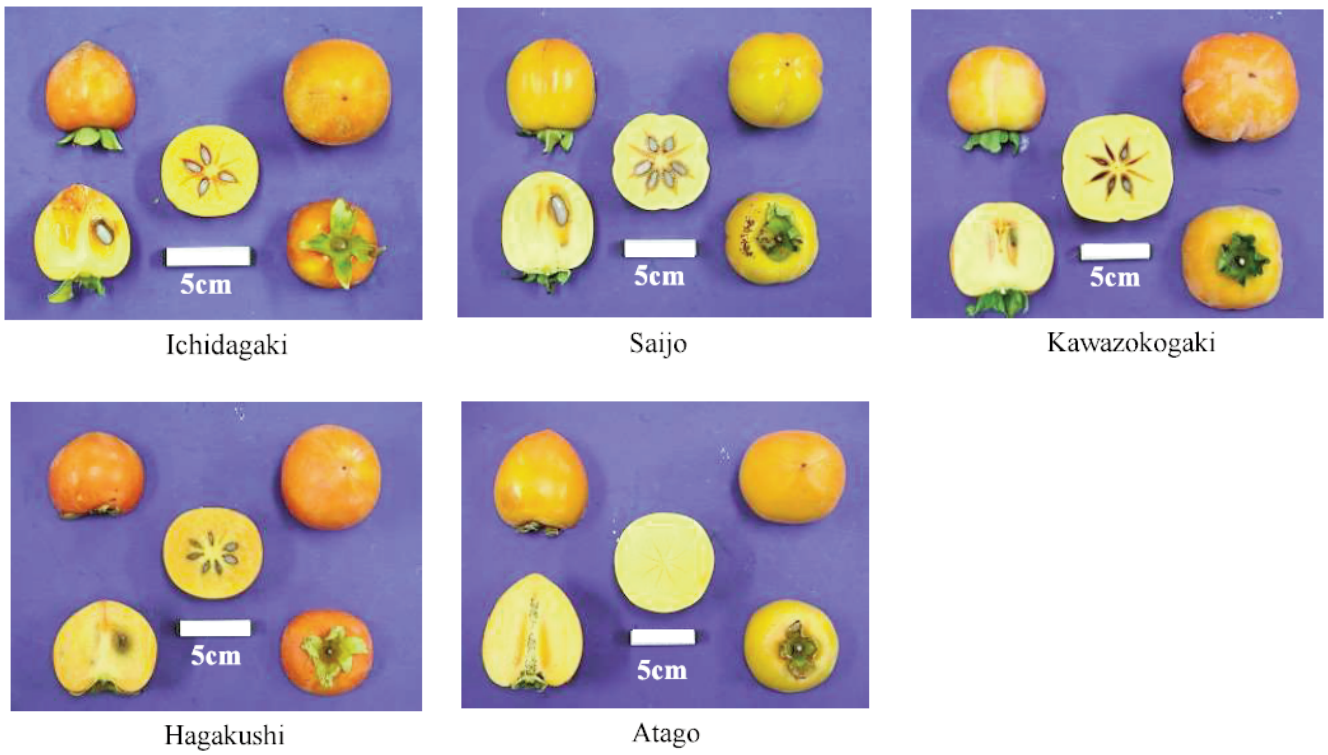

Fig. S4 - Japanese Persimmon cultivars pollination-constant astringent (PCA) type.

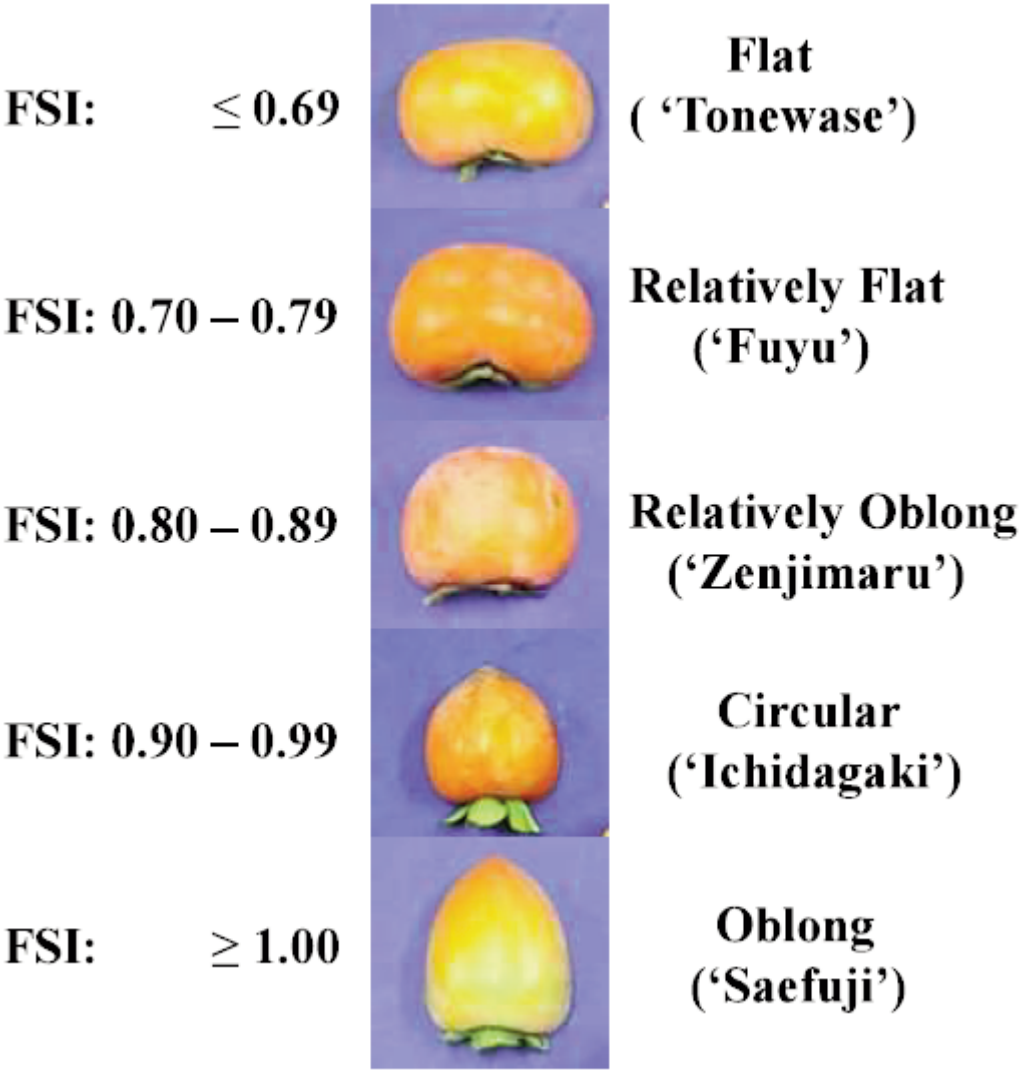

Fig. S5 - Different cultivar shape: Circular, flat, relatively flat, oblong, and relatively oblong,. FSI: Fruit shape index, (longitudinal diameter/transverse diameter), defined according to Maeda *et al.* (2018) with slight modifications.

Table S3 - List of other quality traits of Japanese persimmon cultivars examined in 2016

Cultivar/Selection	Fruit weight (g)	Skin color (apex, CC)	Flesh firmness (kg)	Flesh juiciness (mL g^{-1} FW)
PCNA				
Early-Oct.				
Soushu	299	7.2	1.4	0.27
Mid-Oct.				
Izu	263	7.1	1.4	0.29
Shinshuu	280	4.3	1.5	0.22
Late-Oct.				
Sodawase	432	5.2	1.1	0.27
Reigyoku	336	5.0	1.6	0.36
Taiga	407	5.8	1.4	0.32
Kanshu	247	5.3	2.5	0.17
Kishu	328	5.9	2.0	0.24
Taishu	446	4.0	1.1	0.35
Maekawajiro	308	6.0	2.0	0.22
Tenjingosho	305	6.5	2.0	0.17
Early-Nov.				
Akiou	356	5.3	1.2	0.38
Misatogosho	316	6.2	2.0	0.23
Uenishiwase	296	4.8	2.1	0.13
Matsumotowase-Fuyu	273	6.3	1.8	0.27
Mid-Nov.				
Mushirodagosho	438	5.6	1.5	0.33
Youhou	396	7.7	1.8	0.18
Late-Nov.				
Fuyu	303	6.3	1.7	0.27
Okitsu-20 (Ro-19)	327	5.3	1.5	0.31
Taiho	302	4.9	1.4	0.36
Early-Dec.				
Okugosho	242	7.7	1.9	0.24
Suruga	256	5.5	1.8	0.26
Hanagosho	232	4.1	1.5	0.25
PVNA				
Late-Sept.				
Nishimurawase	227	5.7	3.1	0.16
Early-Oct.				
Akagaki	229	5.7	2.1	0.20
Mid-Oct.				
Fudegaki	136	5.8	2.2	0.21
Ganzan	168	4.1	2.3	0.18
Oomiyawase	195	4.3	2.0	0.20
Saefuji	227	7.2	1.9	0.28
Late-Oct.				
Rendaiji	213	4.4	1.0	0.20
Early-Nov.				
Zenjimaru	227	5.8	2.1	0.25
Early-Dec.				
Shogatsu	400	4.3	1.9	0.19

Astringency removal of PVA- and PCA-type cultivars was performed.

Table S3 - List of other quality traits of Japanese persimmon cultivars examined in 2016

Cultivar/Selection	Fruit weight (g)	Skin color (apex, CC)	Flesh firmness (kg)	Flesh juiciness (mL g^{-1} FW)
PVA				
Mid-Oct.				
Tonewase	292	5.1	1.3	0.25
Early-Nov.				
Hiratanenashi	269	4.1	1.3	0.22
Koshuhyakume	407	6.9	0.5	0.31
Taigetsu	564	5.2	0.6	0.43
Taiten	442	5.0	0.6	0.46
Mid-Nov.				
Aizumishirazu	262	5.0	1.6	0.21
PCA				
Mid-Oct.				
Ichidagaki	158	4.8	0.9	0.35
Late-Oct.				
Saijo	219	3.8	0.7	0.28
Kawazokogaki	293	4.7	0.6	0.31
Early-Nov.				
Hagakushi	228	6.1	0.8	0.26
Mid-Nov.				
Atago	241	4.3	1.4	0.23

Astringency removal of PVA- and PCA-type cultivars was performed.