Report: Laboratory results of honey testing

CSE Study on Adulteration in Honey

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1. Introduction

The Centre for Science and Environment (CSE) conducted an investigation to understand adulteration in honey. As part of this, honey samples were sent for testing at two laboratories. These laboratories were:

- Centre for Analysis and Learning in Livestock and Food (CALF), National Dairy Development Board (NDDB), Gujarat, India
- A renowned food testing laboratory in Germany[1]

This report comprise the results of tests conducted at both laboratories.

2. Samples sent for testing

A total of 13 honey brands were tested. Eight of these are big brands selling processed honey. Five are niche brands. Four out these five sell raw honey.

Samples were purchased during Aug-Nov, 2020 from retail stores in Delhi and major online platforms. For each brand, multiple samples of the same batch were purchased. In addition, in some cases, samples of different batches were also purchased.

Samples sent to CALF, NDDB were tested on parameters set by the Food Safety and Standards Authority of India (FSSAI) operationalized in 2020. Key adulteration parameters are tests for C4/C3 sugars, foreign oligosaccharides, Specific Marker for Rice (SMR) i.e. 2-acetylfuran-3-glucopyranoside (AFGP).

- C4 sugars are those derived from C4 plants (plants using C4 photosynthetic pathway) such as corn, sugarcane
- C3 sugars are those derived from C3 plants (plants using C3 photosynthetic pathway) such as rice, beet root
- Foreign oligosaccharides are starch-based polysaccharide sugars such as from rice and corn

Samples sent to the German lab were tested for Trace Marker for Rice syrup (TMR) and Nuclear Magnetic Resonance (NMR) profiling. These two tests are not part of the current FSSAI standards. NMR is an advanced test to check for adulteration and confirmation of origin of honey.

Samples were sent to the two laboratories in different phases as the study evolved (see Table 1 for details of samples sent for testing).

[1] The name of the German laboratory is not disclosed as per the agreed upon terms and conditions with the laboratory. The same along with other details can be shared with the government enforcement agencies, if required.

Table 1: Details of samples sent for testing

Phase	Samples	Sent to laboratory	Parameters tested for	Test report date
Phase 1	8 processed honey samples (Dabur, Patanjali, Apis Himalaya, Baidyanath, Zandu, Nature's Nectar, Hitkary, Saffola)	CALF, NDDB, India	Quality and adulteration parameters as per FSSAI	September 28, 2020
Phase 2	5 samples (1 processed: Markfed Sohna and 4 raw: Dadev, Indigenous, Hi Honey, Societe Naturelle)			November 1, 2020
Phase 3	13 samples (same batch as phase I and II) and 4 samples (2 each of different batches of Dabur and Saffola*)	German lab	NMR profiling, TMR	November 6-9, 2020
Phase 4	6 spiked samples (adulterated with sugar syrups) and 1 control sample (raw honey)	CALF, NDDB, India	Key adulteration parameters as per FSSAI**	November 6-9, 2020
Phase 5	5 samples (different batch samples of major brands which had failed NMR in phase 3)	German lab	NMR profiling, TMR	November 17-26, 2020

*Additional samples of Dabur and Saffola were sent as they claim that their products are NMR-tested.

** These are tests for C4/C3 sugars and foreign oligosaccharides.

3. Laboratory test results of honey samples – key adulteration parameters

Overall, 17 out of 22 samples (77 per cent) were found to be adulterated. Samples of three out of 13 brands passed all tests. These include five samples in total from Saffola, Markfed Sohna and Nature's Nectar (one out of two samples).

Summary of brand-wise results is mentioned below (for details see Table 2: Laboratory test results of honey samples)

- Dabur honey passed tests for C3 and C4 sugar, but failed the NMR tests on all three samples. In one sample it also failed on TMR
- Patanjali honey passed tests for C3 and C4 sugar, but failed on TMR and NMR tests in both samples
- Apis Himalaya honey failed on test for foreign oligosaccharides and SMR and also failed the TMR and NMR tests
- Baidyanath honey passed tests for C3 and C4 sugar, but failed on NMR. In one sample it also failed on TMR
- Zandu honey passed tests for C3 and C4 sugar and for TMR but failed on NMR
- Nature's Nectar passed tests for C3 and C4 sugar and for TMR. One sample failed NMR and one sample passed NMR
- Hitkary passed tests for C3 and C4 sugar but failed on TMR and NMR
- Saffola honey passed tests for C3 and C4 sugar and passed on TMR and NMR
- Markfed Sohna passed tests for C3 and C4 sugar and passed on TMR and NMR
- Dadev forest honey failed tests for C4 sugar and failed on NMR. It passed on TMR
- Indigenous honey passed tests for C3 and C4 sugar and for TMR, but failed on NMR
- Hi Honey failed tests for C4 and failed on NMR. It passed on TMR
- Societe Naturelle honey failed tests for C4 and passed on foreign oligosaccharides, TMR and NMR

Table 2*:* Laboratory test results of honey samples

			CALF, NDDB						German lab	
S.No.	**Sample No.**	**Brand**	**C4 sugar (%)**	**Δð13C p-h (‰)**	**Δð13C Fru – Glu (‰)**	**Δð13C Max. (‰)**	**Foreign oligosaccharides (% peak area)**	**2-AFGP as specific marker for rice syrup (mg/kg)**	**TMR (ppbw)**	**NMR indicates adulteration/addition of sugar syrup**
	FSSAI Specification		*Max. 7%*	*≥– 1.0*	*± 1.0*	*± 2.1*	*0.7*	*Absent*(MRPL-1 mg/kg)*	*LoQ:15 ppbw*	
1	01	**Dabur honey**	0.0	0.1	-0.1	-1.1	ND	Absent	**25**	**Yes**
2	01A	**Dabur honey**	-	-	-	-	-	-	15*	**Yes**
3	01B	**Dabur honey**	-	-	-	-	-	-	15*	**Yes**
4	02	**Patanjali honey**	0.0	0.3	-0.9	1.0	ND	Absent	**33**	**Yes**
5	02A	**Patanjali honey**	-	-	-	-	-	-	**39**	**Yes**
6	03	**Apis Himalaya honey**	4.6	-0.9	0.1	1.7	**4.9**	**Present**	**27**	**Yes**
7	04	**Baidyanath honey**	4.6	-0.8	0.2	2.1	ND	Absent	ND	**Yes**
8	04A	**Baidyanath honey**	-	-	-	-	-	-	**41**	**Yes**
9	05	**Zandu Pure honey**	2.7	-0.5	0.0	1.3	ND	Absent	ND	**Yes**
10	05A	**Zandu Pure honey**	-	-	-	-	-	-	ND	**Yes**
11	06	**Nature's Nectar honey**	5.4	-0.9	-0.2	2.0	ND	Absent	ND	**Yes**
12	06A	**Nature's Nectar honey**	-	-	-	-	-	-	ND	No
13	07	**Hitkary honey**	1.0	-0.2	0.6	-0.5	ND	Absent	**19**	**Yes**
14	08	**Saffola honey**	1.8	-0.3	0.2	2.0	ND	Absent	ND	No
15	08A	**Saffola honey**	-	-	-	-	-	-	ND	No
16	08B	**Saffola honey**	-	-	-	-	-	-	ND	No
17	09	**Markfed Sohna honey**	5.2	-0.8	-0.1	1.0	ND	Absent	ND	No
18	10	**Dadev honey**	**20.2**	**-3.4**	**5.1**	**5.7**	ND	Absent	ND	**Yes**
19	11	**Indigenous honey**	0.1	0.0	-0.4	-0.9	ND	Absent	ND	**Yes**
20	11A	**Indigenous honey**	-	-	-	-	-	-	ND	**Yes**
21	12	**Hi honey**	**26.6**	**-3.8**	0.6	**10.5**	ND	Absent	ND	**Yes**
22	13	**Societe Naturelle honey**	**8.1**	**-1.3**	-0.1	1.2	ND	Absent	ND	No

Notes: '-'indicates samples not tested for this parameter. 'ND' is not detected. Text in 'Red' indicates that the sample failed test on respective parameter. LoQ is limit of quantification. 'ppbw' is parts per billion by weight. MRPL is Maximum required performance level. *TMR in this case is detected but not above the level of quantification. If TMR is detected above the LoQ, the lab report interprets it as 'Unauthorized addition of rice syrup detected'. If a sample fails on even one test, it is considered adulterated. Δð13C Max (‰): Maximum difference between all measured ð13C values; per mil. Δð13C p-h (‰): The difference in 13C/ 12C between honey and its associated protein extract; per mil. Δð13C Fru – Glu (‰): The difference in 13C/12C ratio between fructose and glucose; per mil

4. Laboratory test results of spiked honey samples – key adulteration parameters

Six honey samples were adulterated by spiking with syrups to check if adulteration with syrups can go undetected. Scientists from CSE's Environmental Monitoring Lab prepared these samples using scientific tools and procedures. These six samples and a control sample (raw honey) were sent for testing for C4/C3 sugars and foreign oligosaccharides at the same Indian laboratory (CALF, NDDB), which had tested other honey samples. Following two sets of syrups which were obtained as part of the investigation were used:

- Syrups sent by syrup manufacturers in China with claims of passing tests for C4/C3 sugar
- Syrup obtained from Jaspur, India known as "all pass" syrup

Syrups were mixed in different proportions (25%, 50%, 75%) in the following two types of honey:

- Raw honey sourced directly from a beekeeper in Bharatpur. This was from the nectar of *ber* plant sucked up by bees in Jaisalmer. This honey was also used as a control sample without mixing with syrup
- A branded honey sample that had passed adulteration tests at CALF, NDDB laboratory

Summary of the test results is mentioned below (for details see Table 3: Laboratory test results of spiked honey samples)

- Samples adulterated with 25% and 50% sugar syrup passed the all tests. This includes those mixed with both Indian and Chinese syrups
- Only one sample with 75% Chinese syrup, failed the test.

Table 3: Laboratory test results of spiked honey samples

S.No.	Sample	Honey type	Adulterated with	Ratio Honey: Syrup (g)	C4 sugar (%)	Δδ13C p-h (‰)	Δδ13C Fru – Glu (‰)	Δδ13C Max. (‰)	Foreign oligosaccharides (% peak area)
	FSSAI specification				*Max. 7%*	*≥– 1.0*	*± 1.0*	*± 2.1*	*0.7*
1	Raw Honey-1	Raw honey	Indian "all pass" syrup	75:25	0.3	-0.1	0.3	2	ND
2	Raw Honey-2	Raw honey	Indian "all pass" syrup	50:50	2.2	-0.4	0.3	0.3	ND
3	Raw Honey-3	Raw honey	Chinese syrup	75:25	0.9	-0.2	0.4	0.5	ND
4	Raw Honey 4	Raw honey	Chinese syrup	25:75	**7.7**	**-1.3**	0.4	1.6	ND
5	Raw Honey-5*	Raw honey	-	100:0	0.0	0.5	0.3	1.7	ND
6	Honey A-1	Processed honey	Chinese syrup	75:25	5.1	-0.8	-0.2	1.1	ND
7	Honey A-2	Processed honey	Chinese syrup	50:50	1.2	-0.2	-0.6	0.5	ND

ND is "Not detected". * This was control sample which was not spiked (raw honey). Text in 'Red' indicates that the sample failed test on respective parameter.

Annexure 1

Laboratory test results of honey samples – quality parameters

Samples of 13 brands of honey were also tested for quality parameters at CALF, NDDB. These were tested as per the latest FSSAI standards of July 2020. For details of tests and results, see Table 4: Laboratory test results of honey samples – quality parameters.

Table 4: Laboratory test results of honey samples – quality parameters

Sl No.	Brand	Specific gravity	Moisture (%)	Total reducing sugars (%)	Sucrose (%)	F/G Ratio	Total Ash (%)	Acidity expressed as formic acid (%)	Free acidity milliequivalents acid/1000 g	Hydroxy Methyl Furfural (HMF) mg/kg	Diastase activity, Schade units	Water insoluble matters (%)	Pollen & plant matter count/g	Proline, mg/kg	Electrical Conductivity mS/cm
FSSAI Specification		*Min. 1.35*	*Max. 20*	*Min. 65*	*Max. 5*	*0.95-1.50*	*Max. 0.5*	*Max. 0.2*	*Max. 50*	*Max. 80*	*Min. 3*	*Max. 0.1*	*Min. 5000*	*Min. 180*	*Max. 0.8*
01	Dabur honey	1.40	18.62	77.61	0.90	1.29	0.10	0.05	10.11	60.78	4.63	0.02	**BLQ**	206.62	0.23
02	Patanjali honey	1.42	19.78	76.81	1.40	1.08	0.13	0.05	11.07	64.38	5.98	0.09	16071.0	182.31	0.32
03	Apis Himalaya honey	1.46	16.11	74.00	0.40	1.05	0.17	0.05	12.03	79.63	**2.19**	0.06	**BLQ**	**132.88**	0.42
04	Baidyanath honey	1.44	18.86	75.03	2.90	1.08	0.06	0.11	25.29	70.30	10.40	0.08	18322.0	264.59	0.48
05	Zandu Pure honey	1.46	17.56	74.57	3.50	1.02	0.08	0.07	15.02	**94.03**	3.13	0.08	19047.0	**151.35**	0.34
06	Nature's Nectar honey	1.42	19.87	77.25	0.80	1.03	0.23	0.10	21.00	**99.80**	13.33	0.04	6889.9	305.77	0.54
07	Hitkary honey	1.44	17.85	81.73	0.90	**1.53**	0.78	0.05	12.21	68.33	3.33	0.07	**BLQ**	**168.62**	0.23
08	Saffola honey	1.44	18.68	77.29	2.00	1.02	0.12	0.07	15.04	33.57	17.43	0.07	**BLQ**	191.25	0.33
09	Markfed Sohna honey	1.44	16.52	74.15	0.80	1.32	0.12	0.09	27.58	**185.60**	5.49	0.09	5211.0	363.60	0.25
10	Dadev honey	1.41	17.28	74.18	1.40	1.49	BLQ	BLQ	8.70	39.22	4.47	0.06	19263.0	**98.30**	0.19
11	Indigenous honey	1.45	16.64	78.58	1.30	1.48	0.15	0.08	17.79	62.42	14.45	0.07	21477.0	306.20	0.52
12	Hi honey	1.45	16.48	68.31	**15.80**	1.38	0.15	BLQ	9.77	35.48	7.68	0.09	11844.0	206.40	0.64
13	Societe Naturelle honey	1.39	19.32	76.53	2.60	1.42	BLQ	0.07	15.14	64.67	4.88	0.04	6987.0	230.80	0.36

Notes: Sl. No is sample number. BLQ is below limit of quantification. In case of pollen & plant matter LoQ is 5000 count/g. F/G ratio is fructose/glucose ratio. Red text indicates sample not meeting specified standards. Results depicted up to 2 decimal places (not rounded-off), except in the case of pollen & plant matter.

Annexure 2

Table 5: Details of samples purchased

Brand (sample no.)	Manufactured/packaged by	Date of manufacture	Best before/date of expiry	Batch/lot no.	Pack size	Price of the sample (Rs)	Purchased from	Date of Purchase
Dabur Honey (01)	Manufactured by: Dabur India Ltd Village Manakpur, Tehsil Baddi District-Solan, HP 174101	25 May, 2020	18 months from packaging	Lot no.: BM3463	600 g (500g + 100g free)	199	Munafa Mart, Kalkaji	August 13, 2020
Dabur Honey (01A)	Manufactured by: Dabur India Ltd Village Manakpur, Tehsil Baddi District-Solan, HP 174101	10 July, 2020	18 months from packaging	Lot no.: BM3589	600 g (500g + 100g free)	199	Krishna Stores, Bengali Market	October 19, 2020
Dabur Honey (01B)	Manufactured by: Dabur India Ltd Village Manakpur, Tehsil Baddi District-Solan, HP 174101	05 August, 2020	18 months from packaging	Lot no.: BM3636	600 g (500g + 100g free)	199	Krishna Stores, Bengali Market	October 19, 2020
Patanjali Honey (02)	Manufactured by: Patanjali Ayurved Ltd. Patanjali Food and Herbal park, Laksar Road, Padartha, Haridwar (Uttarakhand)- 249404	March, 2020	12 months from packaging	Batch no.: BCM045	500 g	145	Easyday club	August 13, 2020
Patanjali Honey (02A)	Manufactured by: Patanjali Ayurved Ltd., Unit-III, Patanjali Food and Herbal park, Village- Padartha, Laksar Road, Haridwar 249404 (Uttarakhand)	September, 2020	12 months from packaging	Batch no.: BCM2000166	500 g	145	Jagdamba Ayurvedic, Laxmi Nagar	November 9, 2020
Apis Himalaya Honey (03)	Manufactured and packed by: Apis India Ltd., Khasra no. 66-72, Makhiali Dundi, Peerpura road Roorkee-247667 Uttarakhand	June, 2020	24 months from packaging	Batch no.: DS25FC071	500 g	240	P.S Enterprises, Sangam Vihar	August 14, 2020
Baidyanath Honey (04)	Manufactured by: Vaidya nutraceuticals (P) Ltd., Village Balyana, PO. Barotiwala, Tehsil-Baddi, District-Solan HP 174103	July, 2020	18 months from packaging	Lot no.: V-158	500 g	199	Rajmandir Hyper Market, Malviya Nagar	August 14, 2020
Baidyanath Honey (04A)	Manufactured by: Vaidya nutraceuticals (P) Ltd. Village Balyana, PO. Barotiwala Tehsil-Baddi, District-Solan HP 174103	August, 2020	18 months from packaging	Lot no.: V-164	500 g	199	Rajmandir Hyper Market, Malviya Nagar	November 9, 2020

Brand (sample no.)	Manufactured/packaged by	Date of manufacture	Best before/date of expiry	Batch/lot no.	Pack size	Price of the sample (Rs)	Purchased from	Date of Purchase
Zandu Pure Honey (05)	Manufactured by: IndoCan Honey Pvt. Ltd., Plot no. 1, Kami Gannaur Road, Village-Kami, District-Sonepat Haryana 131001 Licensed user of Emami Ltd. Kolkata	July, 2020	18 months from packaging	Lot No.: QO0002	500 g	270	Jagdamba Ayurvedic, Laxmi Nagar	August 14, 2020
Zandu Pure Honey (05A)	Manufactured by: IndoCan Honey Pvt. Ltd., Plot no. 1, Kami Gannaur Road, Village-Kami, District-Sonepat Haryana131001 Licensed user of Emami Ltd. Kolkata	September, 2020	18 months from packaging	Lot No.: QO0005	500 g	270	Jagdamba Ayurvedic, Laxmi Nagar	November 9, 2020
Nature's Nectar Honey (06)	Packed by: Kejriwal Bee Care India Pvt. Ltd., Village: Jalalpur, PO: Banur, Rajpura District, Patiala Punjab 140601	29 January, 2020	18 months from packaging	Batch No.: NNC-061	500 g	249	Jain Ayurved, Malviya Nagar	August 14, 2020
Nature's Nectar Honey (06A)	Packed by: Kejriwal Bee Care India Pvt. Ltd., Village: Jalalpur, PO: Banur Rajpura District, Patiala, Punjab 140601	26 September, 2020	18 months from packaging	Batch No.: NNC-062	500 g	249	Store 18 supermarket, Noida	November 10, 2020
Hitkary honey (07)	Manufactured by: Hitkary Pharmacy (I) Pvt. Ltd., 1656, HSIIDC Industrial Estate, Sector-38, Phase 1, Rai, Sonepat, Haryana-131029	8 January, 2020	18 months from packaging	Lot. No.: 052020	500 g	126	Hora Masala Corner, INA market	August 13, 2020
Saffola honey (08)	Manufactured and packed by: Kejriwal Bee Care India Pvt. Ltd., Village: Jalalpur, PO: Banur, Rajpura District, Patiala, Zirakpur-Patiala Highway, Punjab 140601	11 July, 2020	18 months from packaging	Batch No.: K05	250 g X 2	110*2	More Retail Limited, Malviya Nagar	August 21, 2020
Saffola honey (08A)	Manufactured and packed by: Kejriwal Bee Care India Pvt. Ltd., Village: Jalalpur, PO: Banur, Rajpura District, Patiala, Zirakpur-Patiala Highway, Punjab 140601	3 June, 2020	18 months from packaging	Batch No.: K01	500 g	220	More Retail Limited, Malviya Nagar	October 28, 2020
Saffola honey (08B)	Manufactured and packed by: Kejriwal Bee Care India Pvt. Ltd., Village: Jalalpur, PO: Banur, Rajpura	27 July, 2020	18 months from packaging	Batch No.: K07	250 g X 2	110*2	Big Basket	October 28, 2020

Brand (sample no.)	Manufactured/packaged by	Date of manufacture	Best before/date of expiry	Batch/lot no.	Pack size	Price of the sample (Rs)	Purchased from	Date of Purchase
	District, Patiala, Zirakpur-Patiala Highway, Punjab 140601							
Markfed Sohna honey (09)	Manufactured and marketed by: Markfed Canneries, Village Chuharwali, adampur, Distt. Jalandhar, Pin Code-144102, Punjab (India)	June, 2020	12 months from the date of packaging	Batch No.: MCHU1S	500 g	185	Big Basket	September 27, 2020
Dadev honey (10)	Packed and manufactured by: Dadev India Exports Pvt. Limited, 1092, Gali No. 7, Pritam Nagar, karnal, Haryana – 132001	June, 2020	18 months from packaging	Batch No.: 1020/05	750 g	495	Amazon	September 25, 2020
Indigenous honey (11)	Manufactured by: Primitive Corporation, Harinagar, opp Gheewala School, Veraval -362266, Dist: Gir Somnath, Gujarat	16 September, 2020	18 months from packaging	Batch No.: IHAM/1/04/20	500 g	520	Amazon	September 25, 2020
Indigenous honey (11A)	Manufactured by: Primitive Corporation, 11, Madhav Park Industrial area, opp. Podat Int School, Veraval Somnath Bypass road, Veraval -362266, Dist: Gir Somnath, Gujarat	4th November, 2020	18 months from packaging	Batch No.: IHAM/K/11/20	530 g	520	Amazon	September 25, 2020
Hi honey (12)	Packed and marketed by: Saurashtra Honey Bee Farm, C24, D. Vasundhara, Near Varachha Zone Office, Surat, Gujarat – 395006	July, 2020	36 months from packaging	Batch No.: SHBF6588Z	530 g	598	Amazon	September 25, 2020
Societe Naturelle honey (13)	Packed and marketed by: R Singh and Co, S-18E, Shakarpur, School Block, Delhi – 92	1 July, 2020	24 months from packaging	Batch No.: N50720R	500 g	415	The Altitude Store, Meharchand market and Amazon	September 22, 2020 October 28, 2020