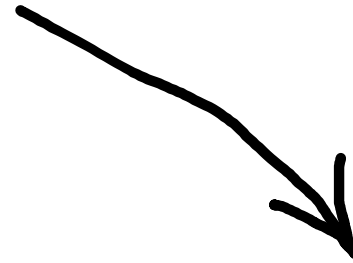
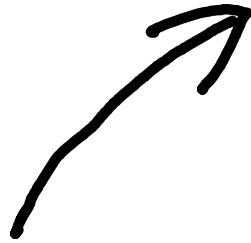




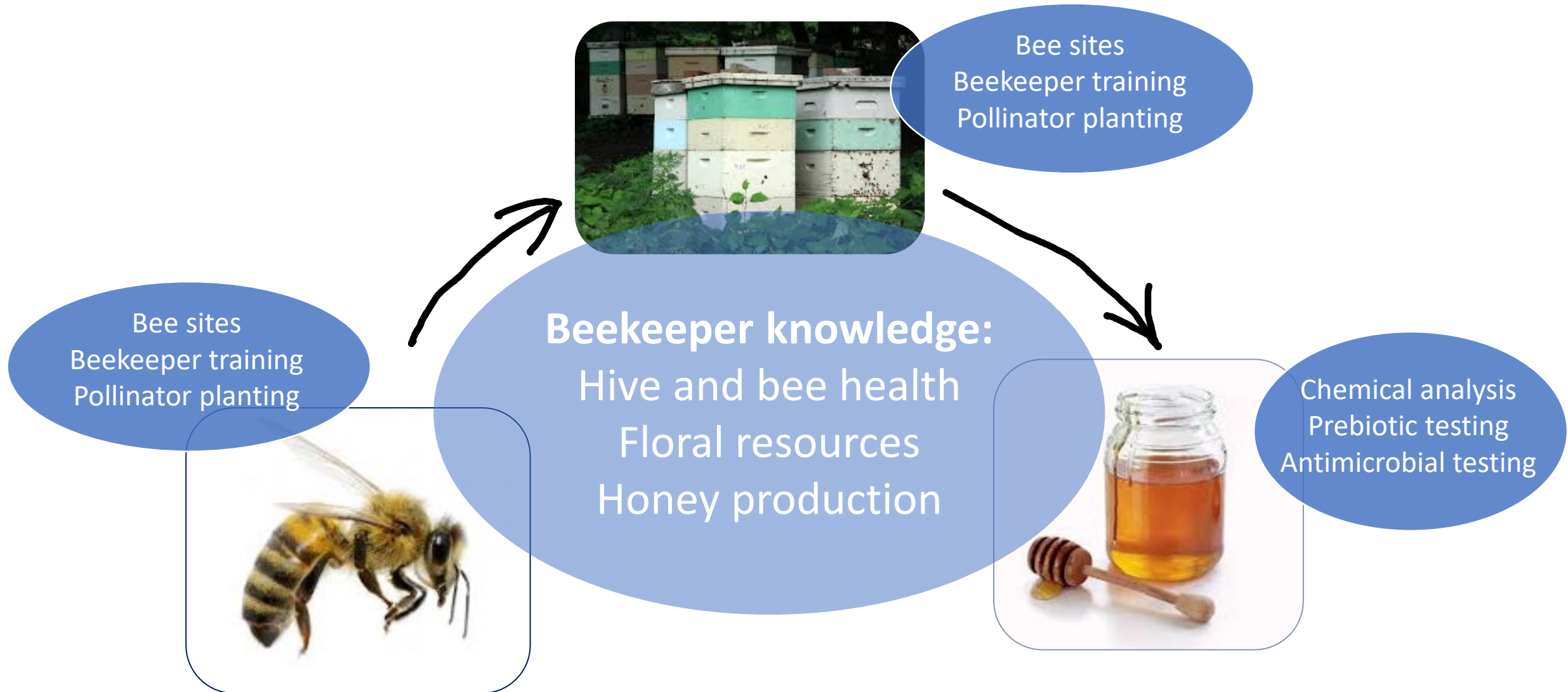
The 6 project parts

1. Audit of NSW government-owned lands for suitability as bee sites (DPI, NSW)
2. Establishing pollinator-friendly plants in rural NSW (Wheen Bee)
3. Upskilling beekeepers – subsidized courses in biosecurity and queen breeding (Tocal College)
4. Safeguarding Honey: Profiling the unique chemical composition of NSW honey (Liz Barbour, CRCHBP)
5. New honey markets: Honey as a health food to fight gut infections (Nural Cokcetin, UTS)
6. Enhancing forest and bee health for high-value medicinal honey: Healthy forests – healthy bees – active honey (Dee Carter, USYD)

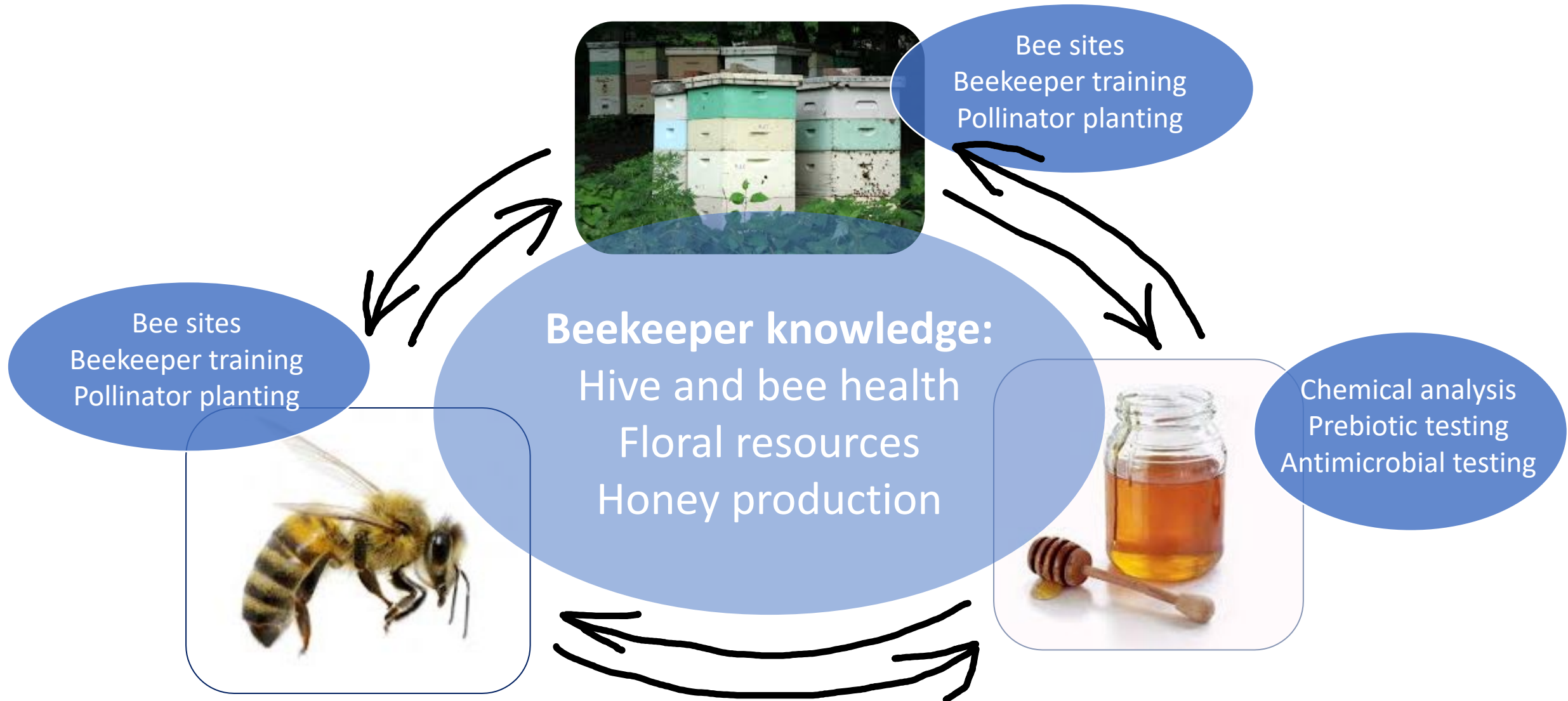
Future-Proofing the NSW Apiary Industry and Keeping Beekeepers in Jobs



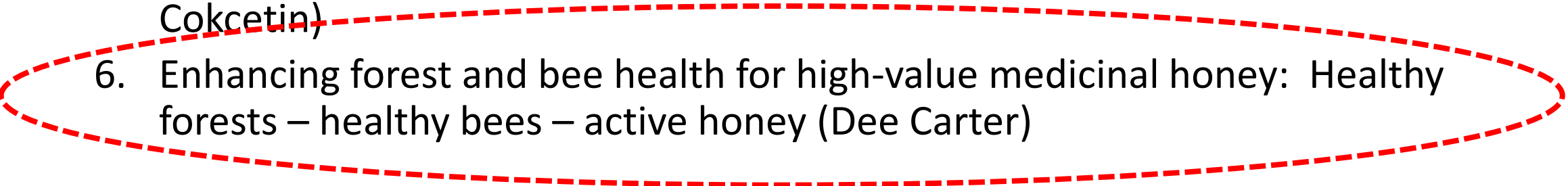
Future-Proofing the NSW Apiary Industry and Keeping Beekeepers in Jobs



Future-Proofing the NSW Apiary Industry and Keeping Beekeepers in Jobs



The 6 project parts

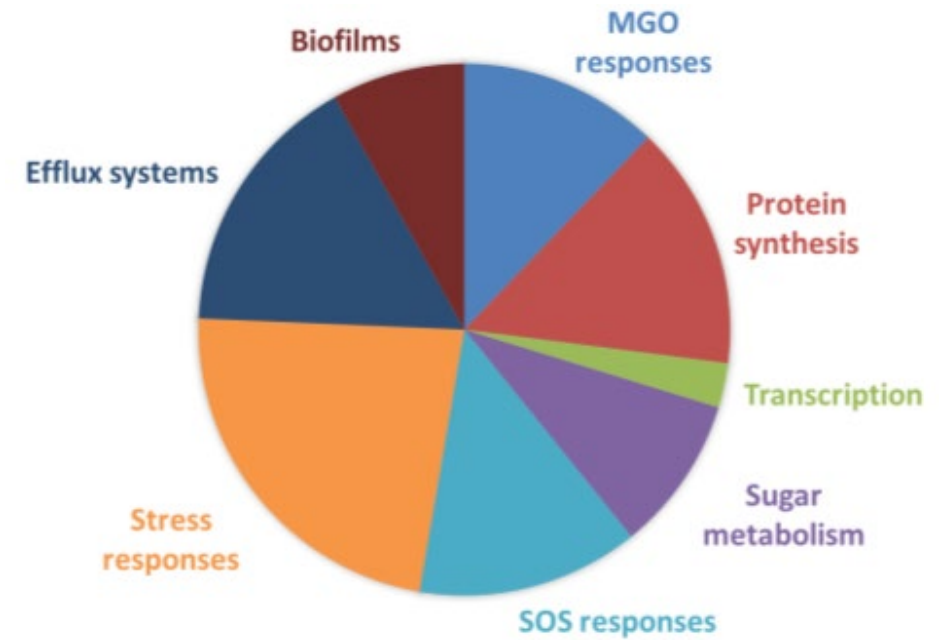
1. Audit of NSW government-owned lands for suitability as bee sites (Stephen Targett/Nick Geoghegan)
 2. Establishing pollinator-friendly plants in rural NSW (Wheen Bee – Fiona Chambers)
 3. Upskilling beekeepers – subsidized courses in biosecurity and queen breeding (Stephen Targett/Nick Geoghegan)
 4. Safeguarding Honey: Profiling the unique chemical composition of NSW honey (Liz Barbour)
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- 

The Carter lab and honey



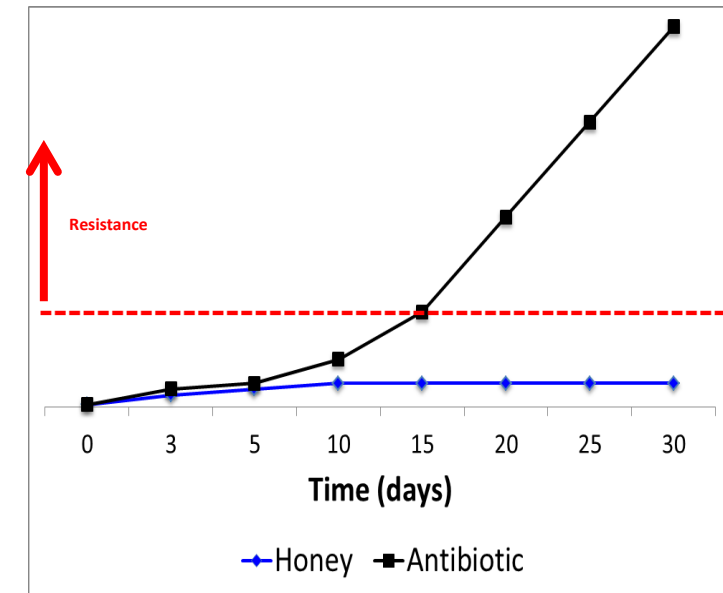
Dr Shona Blair

Dr Nural Cokcetin



Leptospermum honey

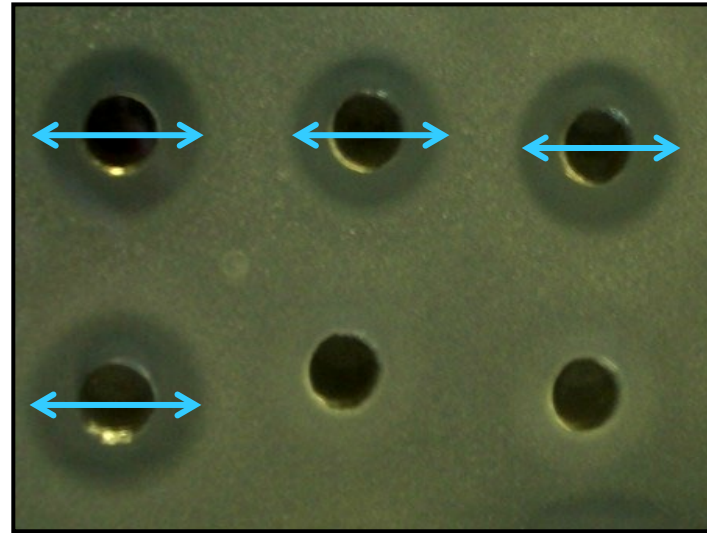
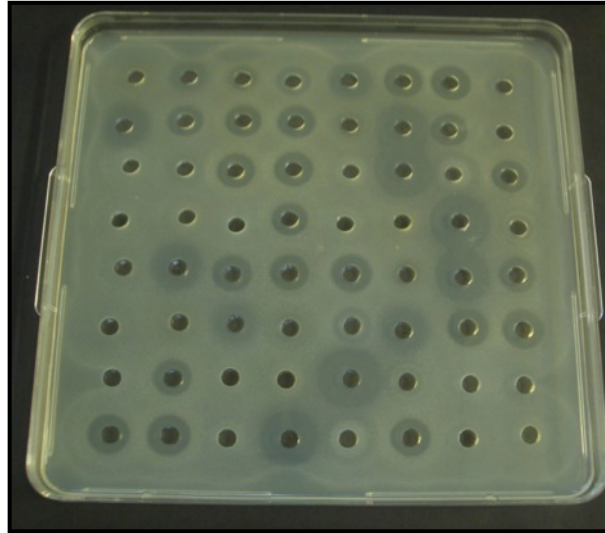
Blair et al. 2009 Eur J Clin Microbiol Infect Dis 28(10):1199



Survey of Australian honeys

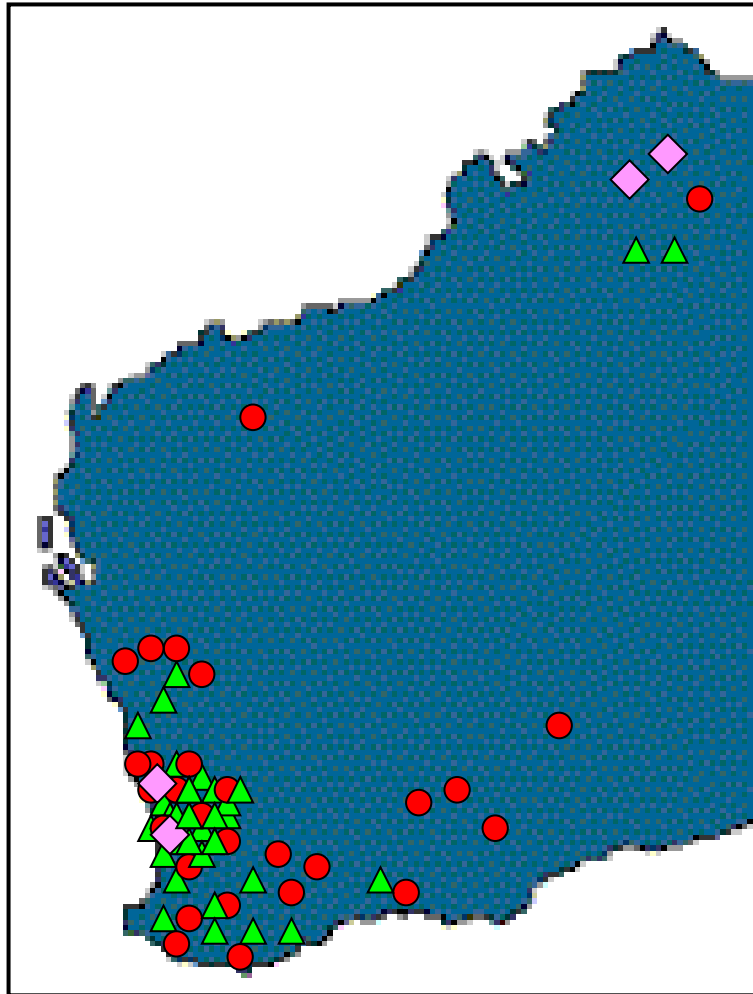


Dr Julie Irish

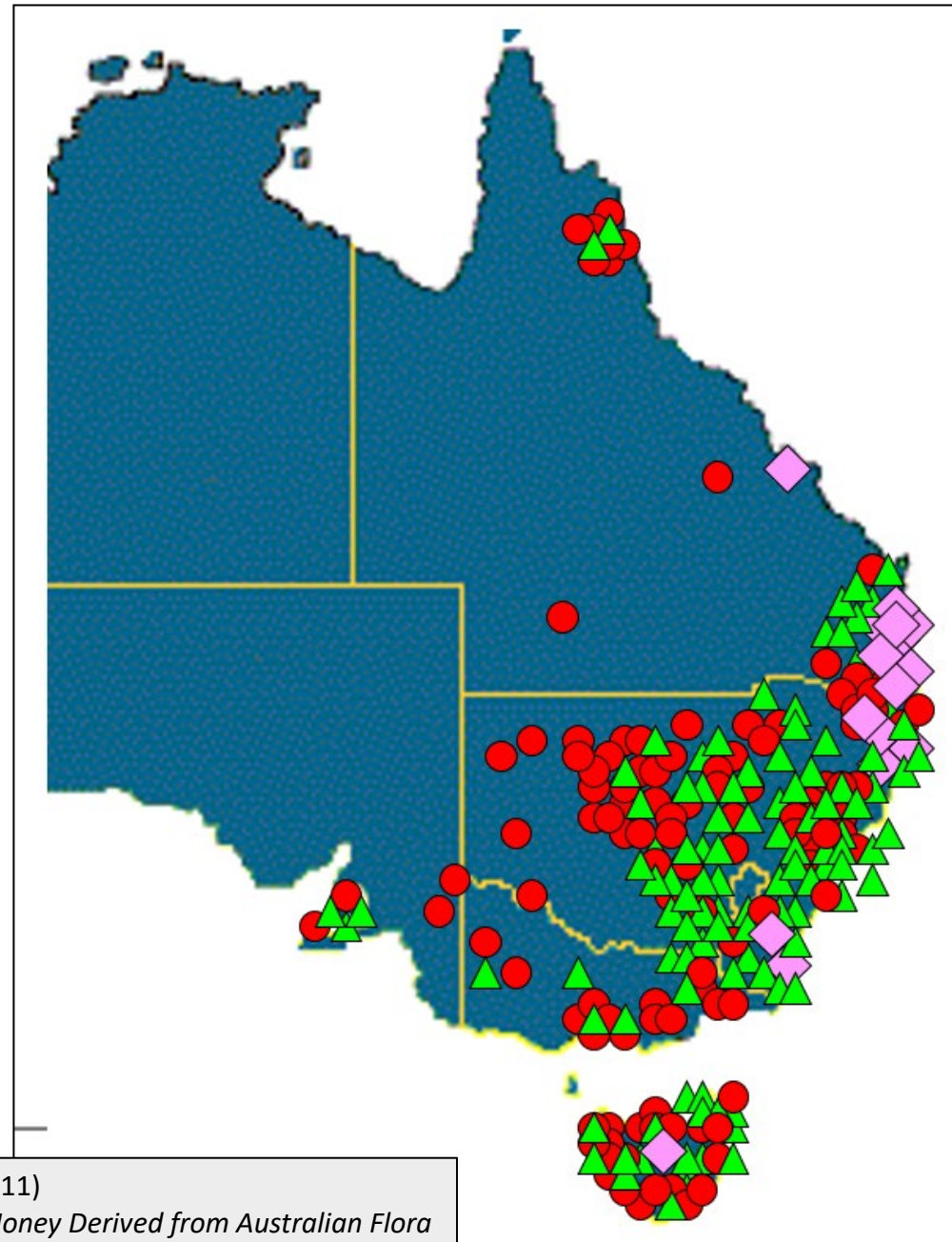


- Tested 470+ honeys from different plants and locations around Australia





- Inactive
- ▲ Hydrogen peroxide activity
- ◆ Non-peroxide activity



Irish J, Blair SE, Carter DA (2011)
The Antibacterial Activity of Honey Derived from Australian Flora
PLoS ONE 6(3): e18229

Julie's table of the most active Australian honeys

Floral source: Common name (Scientific name)	No. samples	No. (%) with detectable activity ¹	Total activity ¹	
			Range	Median
Marri (<i>Corymbia calophylla</i>)	8	7 (88)	<5–29.7	25.7
Jarrah (<i>Eucalyptus marginata</i>)	19	18 (95)	<5–31.4	25.1
Jelly bush and heath flora (<i>Leptospermum polygalifolium</i> and unknown species)	3	3 (100)	17.3–19.9	19.8
Spotted gum (<i>Corymbia maculata</i>)	4	4 (100)	14.7–25.1	18.9
Tea tree and paperbark (<i>Leptospermum semibaccatum</i> and <i>Melaleuca nodosa</i>)	4	4 (100)	18.1–19.6	18.8
Jelly bush (<i>L. polygalifolium</i>)	29	28 (97)	<5–26.2	17.9
Jelly bush, tea tree (<i>Leptospermum</i> sp.)	14	12 (86)	<5–25.8	17.8
Mixed flora, Sydney metropolitan region	32	25 (78)	<5–29.8	15.9
Lemon-scented tea tree (<i>Leptospermum livensidei</i>)	5	5 (100)	14.0–24.5	15.7
Red stringybark (<i>Eucalyptus macrorhyncha</i>)	9	5 (56)	<5–26.1	15.3
Crow's ash and jelly bush (<i>Guioa semiglauc</i> a and <i>L. polygalifolium</i>)	3	2 (67)	<5–19.4	15.2
Banksia (<i>Banksia</i> sp.)	25	22 (88)	<5–24.1	15.0
Jelly bush mix (<i>L. polygalifolium</i> and <i>Leptospermum speciosum</i>)	3	3 (100)	14.2–14.7	14.6
Clover (<i>Trifolium repens</i>)	3	2 (67)	<5–16.3	14.3
Manuka (<i>Leptospermum scoparium</i>)	11	9 (82)	<5–16.3	13.1
Paperbark, tea tree (<i>Melaleuca</i> sp.)	22	18 (82)	<5–19.6	12.8
Mugga ironbark (<i>Eucalyptus sideroxylon</i>)	3	3 (100)	9.7–12.3	11.7
Mixed wildflowers, Tasmania	5	4 (80)	<5–16.1	11.6
Feather bush (<i>Micromyrtus ciliata</i>)	3	2 (67)	<5–13.6	11.5
Other mixed or unknown flora	35	19 (54)	<5–24.6	9.9
Messmate stringybark (<i>Eucalyptus obliqua</i>)	5	3 (60)	<5–15.2	9.8
Snow gum (<i>Eucalyptus pauciflora</i>)	3	2 (67)	<5–10.5	8.7
Tea tree and paperbark (<i>Leptospermum laevigatum</i> and <i>Melaleuca nodosa</i>)	4	2 (50)	<5–16.3	7.7
Tea tree, paperbark (<i>Melaleuca quinquenervia</i>)	3	2 (67)	<5–21.9	7.4
Paterson's curse, Salvation Jane (<i>Echium plantagineum</i>)	4	2 (50)	<5–15.6	6.3
Leatherwood (<i>Eucryphia lucida</i>)	11	4 (36)	<5–17.5	<5
Wandoo (<i>Eucalyptus wandoo</i>)	7	2 (29)	<5–18.7	<5
Lemon-scented tea tree and pink bloodwood (<i>Leptospermum livensidei</i> and <i>Corymbia intermedia</i>)	17	3 (18)	<5–14.6	<5
Eucalyptus (<i>Eucalyptus</i> sp.)	15	5 (33)	<5–24.9	<5
Parrot bush (<i>Dryandra sessilis</i>)	3	1 (33)	<5–21.0	<5
Coastal tea tree (<i>Leptospermum laevigatum</i>)	4	1 (25)	<5–21.4	<5
Mixed rainforest flora, Queensland	3	1 (33)	<5–16.2	<5
Blue gum (<i>Eucalyptus globulus</i>)	3	1 (33)	<5–15.3	<5
Yellow box (<i>Eucalyptus melliodora</i>)	4	1 (25)	<5–12.7	<5

Julie's table of the most active Australian honeys

Floral source: Common name (Scientific name)	No. samples	No. (%) with detectable activity ¹	Total activity ¹	
			Range	Median
Marri (<i>Corymbia calophylla</i>)	8	7 (88)	<5–29.7	25.7
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Lemon-scented tea tree (<i>Leptospermum liversidgei</i>)	5	5 (100)	14.0–24.5	15.7
Red stringybark (<i>Eucalyptus macrorhyncha</i>) *	9	5 (56)	<5–26.1	15.3

Lemon-scented tea tree and pink bloodwood (<i>Leptospermum liversidgei</i> and <i>Corymbia intermedia</i>)	17	3 (18)	<5–14.6	<5
Eucalyptus (<i>Eucalyptus</i> sp.)	15	5 (33)	<5–24.9	<5
Parrot bush (<i>Dryandra sessilis</i>)	3	1 (33)	<5–21.0	<5
Coastal tea tree (<i>Leptospermum laevigatum</i>)	4	1 (25)	<5–21.4	<5
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Blue gum (<i>Eucalyptus globulus</i>)	3	1 (33)	<5–15.3	<5
Yellow box (<i>Eucalyptus melliodora</i>)	4	1 (25)	<5–12.7	<5

Honey and fungi

Medical Mycology May 2006, 44, 289–291



Short Communication

Honey has an antifungal effect against *Candida* species

JULIE IRISH*, DEE A. CARTER*, TAHEREH SHOKOHI† & SHONA E. BLAIR*

*School of Molecular and Microbial Biosciences, University of Sydney, New South Wales, Australia, and †Department of Medical Mycology and Parasitology, Mazandaran University of Medical Sciences, Sari, Iran

The incidence of *Candida* infections is escalating worldwide. The serious nature of these infections is compounded by increasing levels of drug resistance. We report that certain honeys have significant antifungal activity against clinical isolates of *Candida* species. Importantly, the minimum inhibitory concentration of these honeys would be achievable in a clinical setting.

Keywords honey, *Candida*, antifungal effect

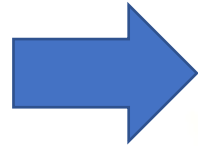
Table 1 Susceptibility of *Candida* species to different honey types^a

	<i>Candida</i> species (n)		
	<i>C. albicans</i> (18)	<i>C. glabrata</i> (10)	<i>C. dubliniensis</i> (10)
Jarrah	18.5 ± 2.7**	29.9 ± 2.8**	15.4 ± 2.8**
Medihoney®	38.2 ± 2.9**	43.1 ± 4.2*	34.6 ± 2.5
Antibacterial Honey Barrier			
Comvita® Wound Care 18+	39.9 ± 1.7**	42.6 ± 2.8**	33.4 ± 2.5
Artificial honey	42.6 ± 1.8	44.7 ± 2.7	34.3 ± 2.4

^aValues show mean minimum inhibitory concentration (% (w/v) honey) ± standard deviation.

P* < 0.002; *P* < 0.00001. *P* values assessed in comparison to artificial honey.

Non-manuka “peroxide”honey and glucose oxidase (GOX)



GOX

Glucose + H₂O → Gluconic acid + H₂O₂

Antimicrobial

Non-Manuka Honey



Anttoni Kakola-Parry



Krish Krishnakumar

ACCESS
MICROBIOLOGY

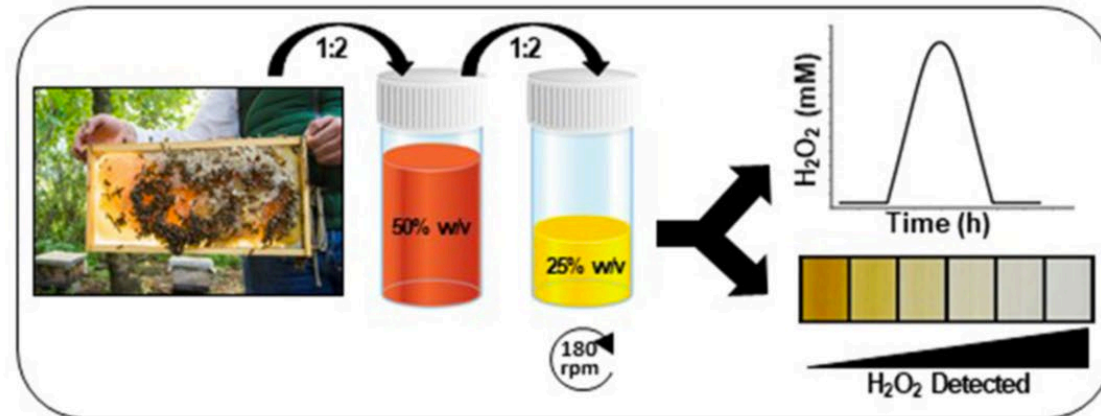
RESEARCH ARTICLE
Lehmann *et al.*, *Access Microbiology*
DOI 10.1099/acmi.0.000065



OPEN
MICROBIOLOGY

A cost-effective colourimetric assay for quantifying hydrogen peroxide in honey

D. M. Lehmann^{1,*}, K. Krishnakumar², M. A. Batres³, A. Hakola-Parry², N. Cokcetin⁴, E. Harry⁴ and D. A. Carter^{2,5}



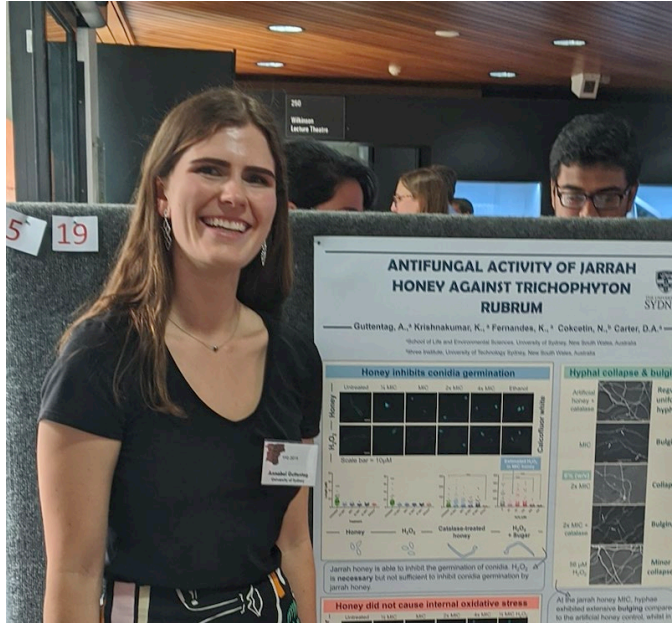
Graphical abstract

H_2O_2 is produced in diluted honey by a biochemical reaction and can be easily quantified using the optimized colourimetric assay described here.

Non-Manuka Honey

ACCESS
MICROBIOLOGY

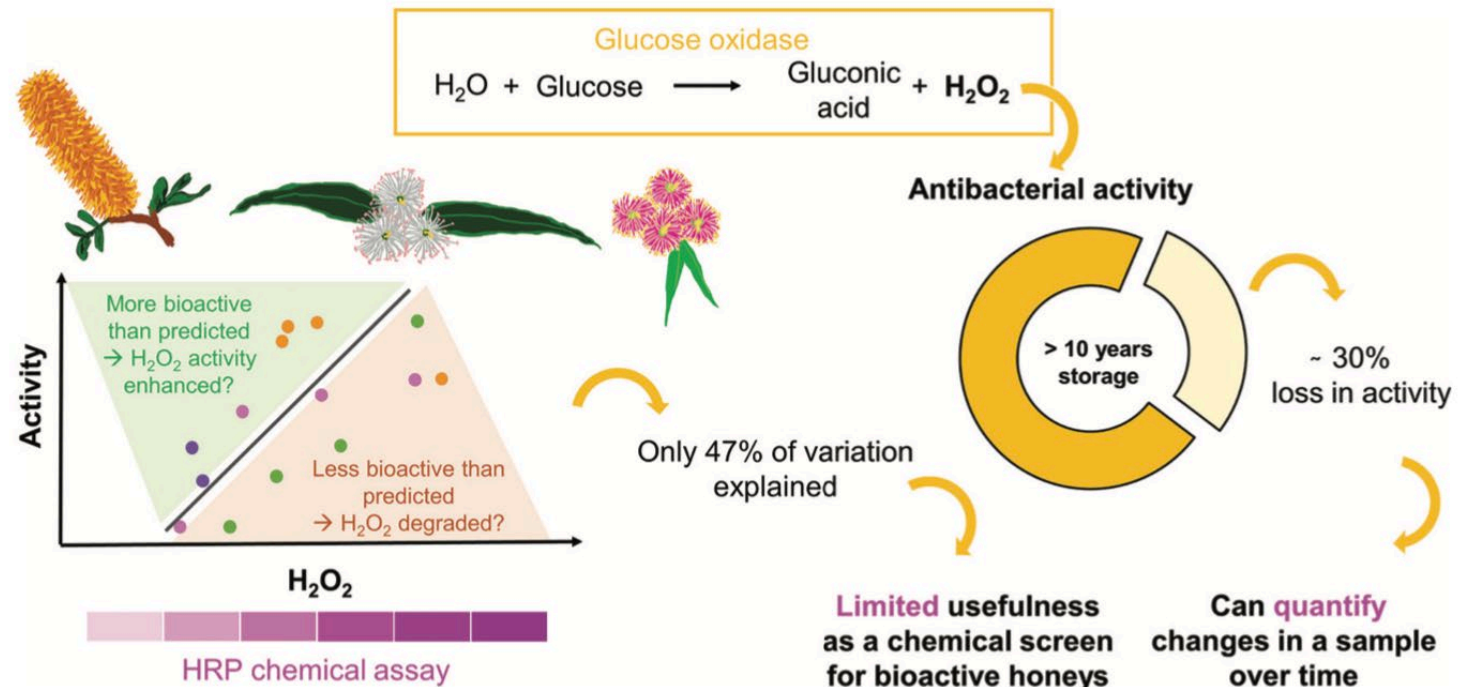
RESEARCH ARTICLE
Guttentag *et al.*, *Access Microbiology*
DOI 10.1099/acmi.0.000198



Annabel Guttentag

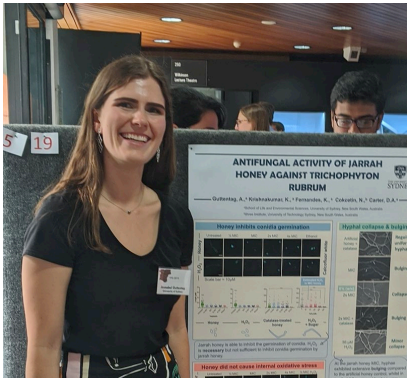
Factors affecting the production and measurement of hydrogen peroxide in honey samples

Annabel Guttentag¹, Krishothman Krishnakumar¹, Nural Cokcetin², Elizabeth Harry² and Dee Carter^{1,*}



Graphical abstract

Jarraah honey and fungi (dermatophytes = ringworm, tinea)



Annabel Guttentag



Article

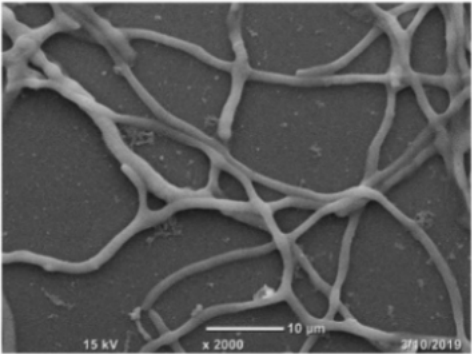
Inhibition of Dermatophyte Fungi by Australian Jarraah Honey

Annabel Guttentag¹, Krishothman Krishnakumar¹, Nural Cokcetin², Steven Hainsworth³, Elizabeth Harry² and Dee Carter^{1,*}

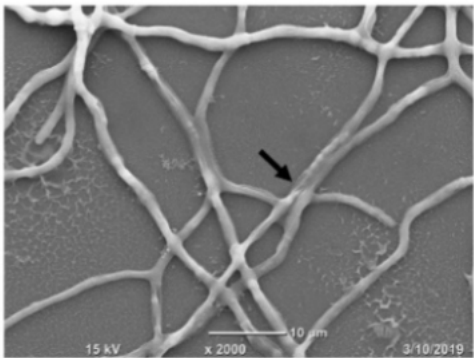
Table 2. Effect of catalase treatment on the antifungal properties of jarraah and stringybark honey.

Catalase Treatment	MIC ₁₀₀ [% (w/v)]					
	Jarraah (Barnes 10+)		Jarraah 10/13		Stringybark 19	
	–	+	–	+	–	+
<i>Nannizzia gypsea</i>	3.1	25	1.56	25	3.1	25
<i>Trichophyton interdigitale</i>	3.1	≥ 25	1.56	≥ 25	4.2 ± 1.0	> 25
<i>Trichophyton rubrum</i>	1.56	25	1.56	25	1.56	25

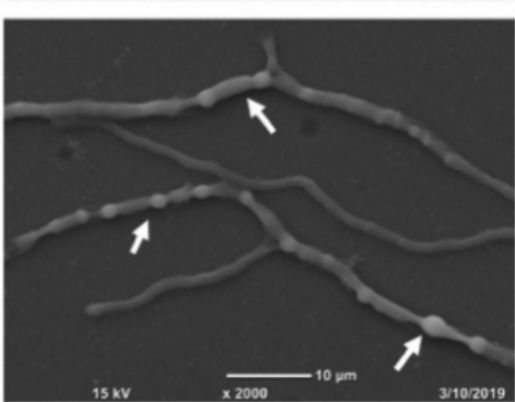
Artificial honey



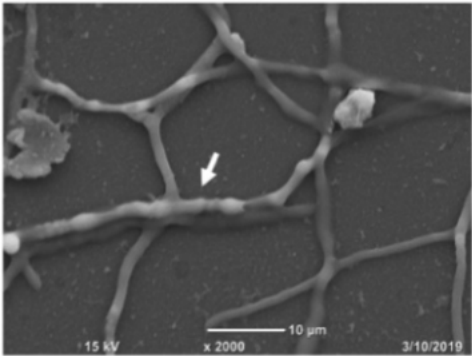
Artificial honey + H₂O₂



Jarraah honey



Jarraah honey + catalase



Summary: things we have found out about non-manuka (H_2O_2) honey

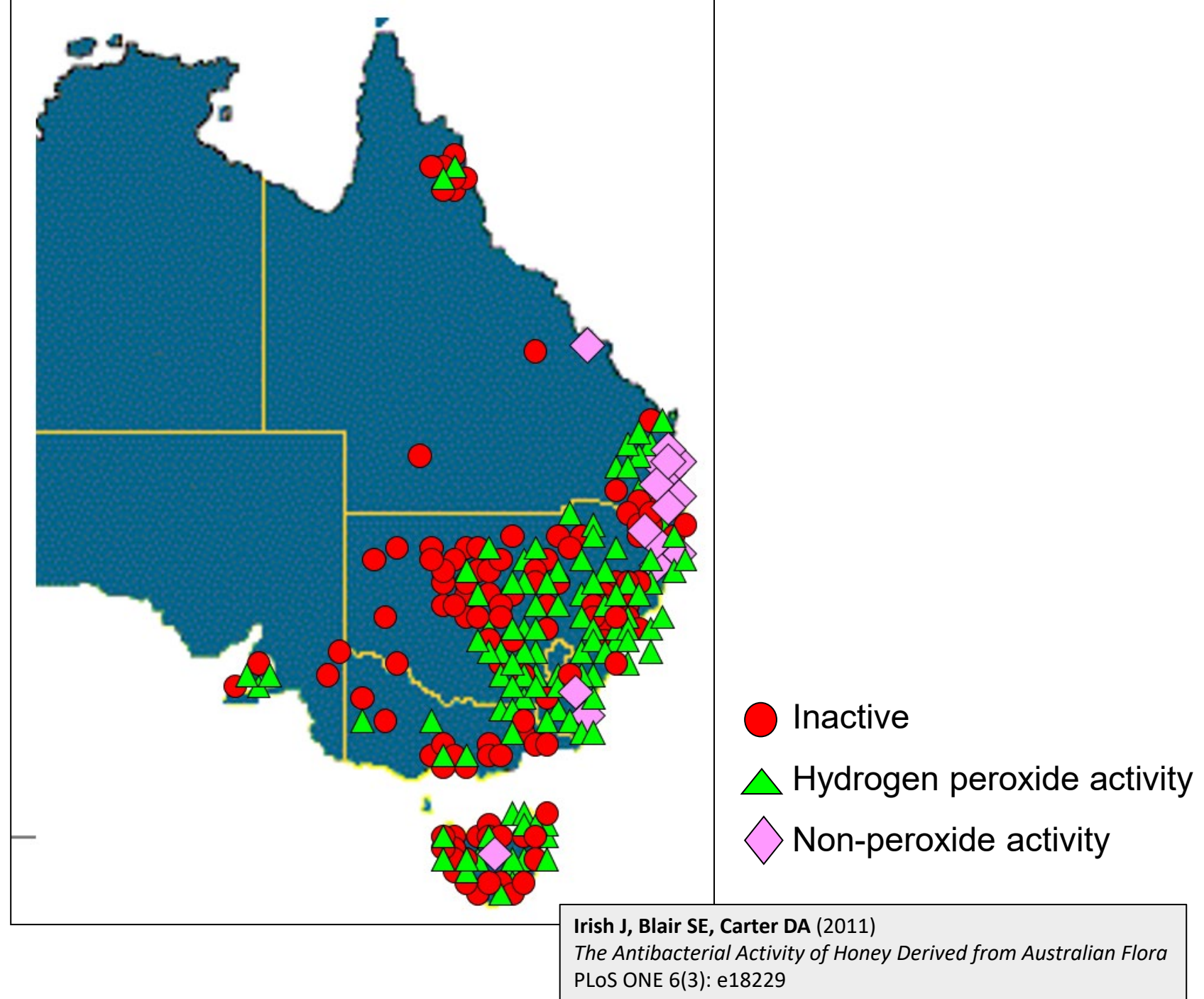
- Much more **antifungal** than manuka honey
- **Jarrah and marri** honey have really high activity
- Antibacterial/antifungal activity abolished by **catalase**
 - Critically dependent on H_2O_2
- Antibacterial/antifungal activity does **not** always **correlate** with H_2O_2 production
- Activity enhanced/reduced by **other factors** present in honey
 - Phenolics? Peptides? Maillard reaction products?
- Dermatophytes are particularly **susceptible** to jarrah honey

Non-manuka honey (H_2O_2) honey

Questions:

1. Why does H_2O_2 vary by plant source? Why is jarrah so high? How do NSW honeys compare?
2. Why is $\text{H}_2\text{O}_2 \neq$ antimicrobial activity?
3. What causes dermatophytes to be so susceptible and is antifungal activity a potential market?

What do we know about antimicrobial NSW honey?



Interesting NSW samples with peroxide activity

Banksia Honey

Code	Common name	Scientific name	Region	Total activity (TA)	Non-peroxide activity (NPA)
B11	Banksia	<i>Banksia sp.</i>	Illawarra	17.1	0
B12	Banksia	<i>Banksia sp.</i>	Illawarra	18.5	0
B13	Banksia	<i>Banksia sp.</i>	Illawarra	17.1	0
B14	Banksia	<i>Banksia sp.</i>	Illawarra	13	0
B15	Banksia	<i>Banksia sp.</i>	Illawarra	16.5	0
B16	Banksia	<i>Banksia sp.</i>	Illawarra	19.2	0
B17	Banksia	<i>Banksia sp.</i>	Illawarra	0	0
B18	Banksia	<i>Banksia sp.</i>	Illawarra	17.5	0
B19	Banksia	<i>Banksia sp.</i>	Illawarra	17.7	0
B20	Banksia	<i>Banksia sp.</i>	Illawarra	16.7	0
B21	Banksia	<i>Banksia sp.</i>	Illawarra	14.2	0
B22	Banksia	<i>Banksia sp.</i>	Illawarra	15	0
B23	Banksia	<i>Banksia sp.</i>	Illawarra	15.3	0
B24	Banksia	<i>Banksia sp.</i>	Illawarra	15.1	0
B25	Banksia	<i>Banksia sp.</i>	Illawarra	15.2	0
B26	Banksia	<i>Banksia sp.</i>	Illawarra	15	0
B27	Banksia	<i>Banksia sp.</i>	Illawarra	11.4	0
B28	Banksia	<i>Banksia sp.</i>	Illawarra	15	0
B29	Banksia	<i>Banksia sp.</i>	Illawarra	13	0
B30	Banksia	<i>Banksia sp.</i>	Illawarra	12.1	0
B31	Banksia	<i>Banksia sp.</i>	Illawarra	13.2	0
B32	Banksia	<i>Banksia sp.</i>	Illawarra	13	0

Average: 15.3

Range: 11.4–19.2

Tea Tree Honey

Code	Common name	Scientific name	Region	Total activity (TA)	Non-peroxide activity (NPA)
T11	Tea tree	<i>Melaleuca sp.</i>	Illawarra	10.8	0
T12	Tea tree	<i>Melaleuca sp.</i>	Illawarra	13.2	0
T13	Tea tree	<i>Melaleuca sp.</i>	Illawarra	0	0
T14	Tea tree	<i>Melaleuca sp.</i>	Illawarra	10.9	0
T15	Tea tree	<i>Melaleuca sp.</i>	Illawarra	13.2	0
T16	Tea tree	<i>Melaleuca sp.</i>	Illawarra	12.2	0
T17	Tea tree	<i>Melaleuca sp.</i>	Illawarra	13.7	0
T18	Tea tree	<i>Melaleuca sp.</i>	Illawarra	12.9	0
T19	Tea tree	<i>Melaleuca sp.</i>	Illawarra	0	0
T20	Tea tree	<i>Melaleuca sp.</i>	Illawarra	12.2	0
T21	Tea tree	<i>Melaleuca sp.</i>	Illawarra	12.6	0
T22	Tea tree	<i>Melaleuca sp.</i>	Illawarra	13	0
T23	Tea tree	<i>Melaleuca sp.</i>	Illawarra	11.6	0
T24	Tea tree	<i>Melaleuca sp.</i>	Illawarra	10.9	0
T25	Tea tree	<i>Melaleuca sp.</i>	Illawarra	0	0
T26	Tea tree	<i>Melaleuca sp.</i>	Illawarra	0	0
T27	Tea tree	<i>Melaleuca sp.</i>	Illawarra	13	0
T28	Tea tree	<i>Melaleuca sp.</i>	Illawarra	14.3	0
T5	Tea tree	<i>M. quinquenervia</i>	Northern Rivers	7.4	0

Average: 12.1

Range: 7.4–14.3

Interesting
NSW samples
with peroxide
activity

Others

Code	Common name	Scientific name	Region	Total activity (TA)	Non-peroxide activity (NPA)
IB4	Grey ironbark	<i>Eucalyptus paniculata</i>	Mid North Coast	15.2	0
IB6	Grey ironbark	<i>Eucalyptus paniculata</i>	South Coast	15.6	0
IB10	Grey ironbark and broadleaf ironbark	<i>Eucalyptus siderophloia</i> , <i>E. fibrosa</i>	Northern Tablelands	19	0
ET1	Grey ironbark, turpentine, eriostemon	<i>Eucalyptus paniculata</i> , <i>Syncarpia glomulifera</i> , <i>Eriostemon</i> sp.	Illawarra	25.7	0
IB5	Ironbark/Red bloodwood	<i>Eucalyptus tricarpa</i> , <i>E. gummifera</i>	South Coast	20	0
PB1	Paperbark	<i>Melaleuca</i> sp.	Metropolitan	19.6	0
PB7	Paperbark	<i>Melaleuca linarifolia</i>	Illawarra	21.1	0
SB14	Red stringybark	<i>Eucalyptus macrothynea</i>	Central Tablelands	25.2	0
SB16	Red stringybark	<i>Eucalyptus macrothynea</i>	South West Slopes	15.3	0
SB2	Red stringybark	<i>Eucalyptus macrothynea</i>	Central Tablelands	0	0
SB6	Red stringybark	<i>Eucalyptus macrothynea</i>	Central Tablelands	0	0
SB7	Red stringybark	<i>Eucalyptus macrothynea</i>	South West Slopes	25.3	0
AB1	Apple box/red stringybark	<i>Eucalyptus bridgesiana</i> , <i>Eucalyptus macrothynea</i>	Southern Tablelands	34.3	0
SG1	Spotted gum	<i>Eucalyptus maculata</i>	South Coast	25.1	10.1
SG3	Spotted gum	<i>Eucalyptus maculata</i>	South Coast	22.4	10.3
SG4	Spotted gum	<i>Eucalyptus maculata</i>	South Coast	17	9.1
SG7	Spotted gum	<i>Eucalyptus maculata</i>	South Coast	14.7	9.9
SB17	Spotted gum, bloodwood	<i>Eucalyptus maculata</i> , <i>Eucalyptus gummifera</i>	South Coast	0	0
SS1	Spotted gum, stringybark	<i>Eucalyptus maculata</i> , <i>Eucalyptus laevopinea</i> ?	Northern Tablelands	22.3	0

Grey Ironbark

Average: 19.1

Range: 15.2-25.7

Interesting
NSW samples
with peroxide
activity

Others

Code	Common name	Scientific name	Region	Total activity (TA)	Non-peroxide activity (NPA)
IB4	Grey ironbark	<i>Eucalyptus paniculata</i>	Mid North Coast	15.2	0
IB6	Grey ironbark	<i>Eucalyptus paniculata</i>	South Coast	15.6	0
IB10	Grey ironbark and broadleaf ironbark	<i>Eucalyptus siderophloia</i> , <i>E. fibrosa</i>	Northern Tablelands	19	0
ET1	Grey ironbark, turpentine, eriostemon	<i>Eucalyptus paniculata</i> , <i>Syncarpia glomulifera</i> , <i>Eriostemon</i> sp.	Illawarra	25.7	0
IB5	Ironbark/Red bloodwood	<i>Eucalyptus tricarpa</i> , <i>E. gummifera</i>	South Coast	20	0
PB1	Paperbark	<i>Melaleuca</i> sp.	Metropolitan	19.6	0
PB7	Paperbark	<i>Melaleuca linariifolia</i>	Illawarra	21.1	0
SB14	Red stringybark	<i>Eucalyptus macrohynca</i>	Central Tablelands	25.2	0
SB16	Red stringybark	<i>Eucalyptus macrohyncha</i>	South West Slopes	15.3	0
SB2	Red stringybark	<i>Eucalyptus macrohynca</i>	Central Tablelands	0	0
SB6	Red stringybark	<i>Eucalyptus macrohynca</i>	Central Tablelands	0	0
SB7	Red stringybark	<i>Eucalyptus macrohynca</i>	South West Slopes	25.3	0
AB1	Apple box/red stringybark	<i>Eucalyptus bridgesiana</i> , <i>Eucalyptus macrohynca</i>	Southern Tablelands	34.3	0
SG1	Spotted gum	<i>Eucalyptus maculata</i>	South Coast	25.1	10.1
SG3	Spotted gum	<i>Eucalyptus maculata</i>	South Coast	22.4	10.3
SG4	Spotted gum	<i>Eucalyptus maculata</i>	South Coast	17	9.1
SG7	Spotted gum	<i>Eucalyptus maculata</i>	South Coast	14.7	9.9
SB17	Spotted gum, bloodwood	<i>Eucalyptus maculata</i> , <i>Eucalyptus gummifera</i>	South Coast	0	0
SS1	Spotted gum, stringybark	<i>Eucalyptus maculata</i> , <i>Eucalyptus laevopinea?</i>	Northern Tablelands	22.3	0

Red Stringybark

Average: 25.1
Range: 15.3-34.3

Interesting
NSW samples
with peroxide
activity

Others

Code	Common name	Scientific name	Region	Total activity (TA)	Non-peroxide activity (NPA)
IB4	Grey ironbark	<i>Eucalyptus paniculata</i>	Mid North Coast	15.2	0
IB6	Grey ironbark	<i>Eucalyptus paniculata</i>	South Coast	15.6	0
IB10	Grey ironbark and broadleaf ironbark	<i>Eucalyptus siderophloia</i> , <i>E. fibrosa</i>	Northern Tablelands	19	0
ET1	Grey ironbark, turpentine, eriostemon	<i>Eucalyptus paniculata</i> , <i>Syncarpia glomulifera</i> , <i>Eriostemon</i> sp.	Illawarra	25.7	0
IB5	Ironbark/Red bloodwood	<i>Eucalyptus tricarpa</i> , <i>E. gummifera</i>	South Coast	20	0
PB1	Paperbark	<i>Melaleuca</i> sp.	Metropolitan	19.6	0
PB7	Paperbark	<i>Melaleuca linarifolia</i>	Illawarra	21.1	0
SB14	Red stringybark	<i>Eucalyptus macrorhynca</i>	Central Tablelands	25.2	0
SB16	Red stringybark	<i>Eucalyptus macrorhyncha</i>	South West Slopes	15.3	0
SB2	Red stringybark	<i>Eucalyptus macrorhynca</i>	Central Tablelands	0	0
SB6	Red stringybark	<i>Eucalyptus macrorhynca</i>	Central Tablelands	0	0
SB7	Red stringybark	<i>Eucalyptus macrorhynca</i>	South West Slopes	25.3	0
AB1	Apple box/red stringybark	<i>Eucalyptus bridgesiana</i> , <i>Eucalyptus macrorhynca</i>	Southern Tablelands	34.3	0
SG1	Spotted gum	<i>Eucalyptus maculata</i>	South Coast	25.1	10.1
SG3	Spotted gum	<i>Eucalyptus maculata</i>	South Coast	22.4	10.3
SG4	Spotted gum	<i>Eucalyptus maculata</i>	South Coast	17	9.1
SG7	Spotted gum	<i>Eucalyptus maculata</i>	South Coast	14.7	9.9
SB17	Spotted gum, bloodwood	<i>Eucalyptus maculata</i> , <i>Eucalyptus gummifera</i>	South Coast	0	0
SS1	Spotted gum, stringybark	<i>Eucalyptus maculata</i> , <i>Eucalyptus laevopinea</i> ?	Northern Tablelands	22.3	0

Spotted gum

Average: 22.3

Range: 14.7-25.1

Interesting
NSW samples
with peroxide
activity

Honey from mixed flora

Code	Common name	Region	Total activity (TA)	Non-peroxide activity (NPA)
P12	Mixed	Metropolitan	19.4	0
P13	Mixed	Metropolitan	21.2	0
P17	Mixed	Metropolitan	0	0
P18	Mixed	Metropolitan	0	0
P19	Mixed	Hunter	0	0
P20	Mixed	Metropolitan	0	0
P21	Mixed	Metropolitan	0	0
P22	Mixed	Metropolitan	0	0
P23	Mixed	Hunter	18.3	0
P24	Mixed	Hunter	18.9	0
P25	Mixed	Metropolitan	13.8	0
P26	Mixed	Metropolitan	15.7	0
P27	Mixed	Metropolitan	0	0
P28	Mixed	Metropolitan	15	0
P29	Mixed	Metropolitan	29.8	0
P30	Mixed	Metropolitan	22.7	0
P31	Mixed	Metropolitan	8.1	0
P32	Mixed	Metropolitan	22	0
P33	Mixed	Mid North Coast	24.6	0
P34	Mixed	Metropolitan	17	0
P35	Mixed	Metropolitan	21	0
P40	Mixed	Metropolitan	0	0
P41	Mixed	Metropolitan	13.8	0
P42	Mixed	Central Tablelands	17.8	0
P43	Mixed	Central Tablelands	15.1	0
P7	Mixed	Metropolitan	15.8	0
P8	Mixed	Metropolitan	16.4	0
P9	Mixed	Metropolitan	17	0
P14	Mixed urban	Metropolitan	16	0
P15	Mixed urban	Metropolitan	16.4	0
P16	Mixed urban	Metropolitan	23.2	0

Average: 18.2

Range: 8.1–29.8

Julie's table of the most active Australian honeys

Floral source: Common name (Scientific name)	No. samples	No. (%) with detectable activity ¹	Total activity ¹	
			Range	Median
Marri (<i>Corymbia calophylla</i>)	8	7 (88)	<5–29.7	25.7
Jarrah (<i>Eucalyptus marginata</i>)	19	18 (95)	<5–31.4	25.1
Jelly bush and heath flora (<i>Leptospermum polygalifolium</i> and unknown species)	3	3 (100)	17.3–19.9	19.8
Spotted gum (<i>Corymbia maculata</i>)	4	4 (100)	14.7–25.1	18.9
Tea tree and paperbark (<i>Leptospermum semibaccatum</i> and <i>Melaleuca nodosa</i>)	4	4 (100)	18.1–19.6	18.8
Jelly bush (<i>L. polygalifolium</i>)	29	28 (97)	<5–26.2	17.9
Jelly bush, tea tree (<i>Leptospermum</i> sp.)	14	12 (86)	<5–25.8	17.8

Mixed flora, Sydney metropolitan region	32	25 (78)	<5–29.8	15.9
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Red stringybark (<i>Eucalyptus macrorhyncha</i>)	9	5 (56)	<5–26.1	15.3
Crow's ash and jelly bush (<i>Guioa semiglauc</i> a and <i>L. polygalifolium</i>)	3	2 (67)	<5–19.4	15.2
Banksia (<i>Banksia</i> sp.)	25	22 (88)	<5–24.1	15.0
Jelly bush mix (<i>L. polygalifolium</i> and <i>Leptospermum speciosum</i>)	3	3 (100)	14.2–14.7	14.6
Clover (<i>Trifolium repens</i>)	3	2 (67)	<5–16.3	14.3
Manuka (<i>Leptospermum scoparium</i>)	11	9 (82)	<5–16.3	13.1
Paperbark, tea tree (<i>Melaleuca</i> sp.)	22	18 (82)	<5–19.6	12.8
Mugga ironbark (<i>Eucalyptus sideroxylon</i>)	3	3 (100)	9.7–12.3	11.7
Mixed wildflowers, Tasmania	5	4 (80)	<5–16.1	11.6
Feather bush (<i>Micromyrtus ciliata</i>)	3	2 (67)	<5–13.6	11.5

Diet effects on honeybee immunocompetence

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Protection de l'abeille, Domaine Saint-Paul, 84914 Avignon, France

*Author for correspondence (cedric.alaux@avignon.inra.fr).



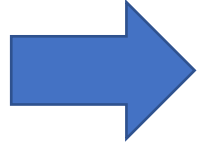
The maintenance of the immune system can be costly, and a lack of dietary protein can increase the susceptibility of organisms to disease. However, few studies have investigated the relationship between protein nutrition and immunity in insects. Here, we tested in honeybees (*Apis mellifera*) whether dietary protein quantity (monofloral pollen) and diet diversity (polyfloral pollen) can shape baseline immunocompetence (IC) by measuring parameters of individual immunity (haemocyte concentration, fat body content and phenoloxidase activity) and **glucose oxidase (GOX) activity**, which enables bees to sterilize colony and brood food, as a parameter of social immunity. Protein feeding modified both individual and social IC but increases in dietary protein quantity did not enhance IC. **However, diet diversity increased IC levels. In particular, polyfloral diets induced higher GOX activity compared with monofloral diets, including protein-rich diets.** These results suggest a link between protein nutrition and immunity in honeybees and underscore the critical role of resource availability on pollinator health.



Enhancing forest and bee health for high-value medicinal honey: *Healthy forests – healthy bees – active honey*

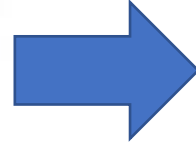


Biodiverse floral resources



GOX

GOX



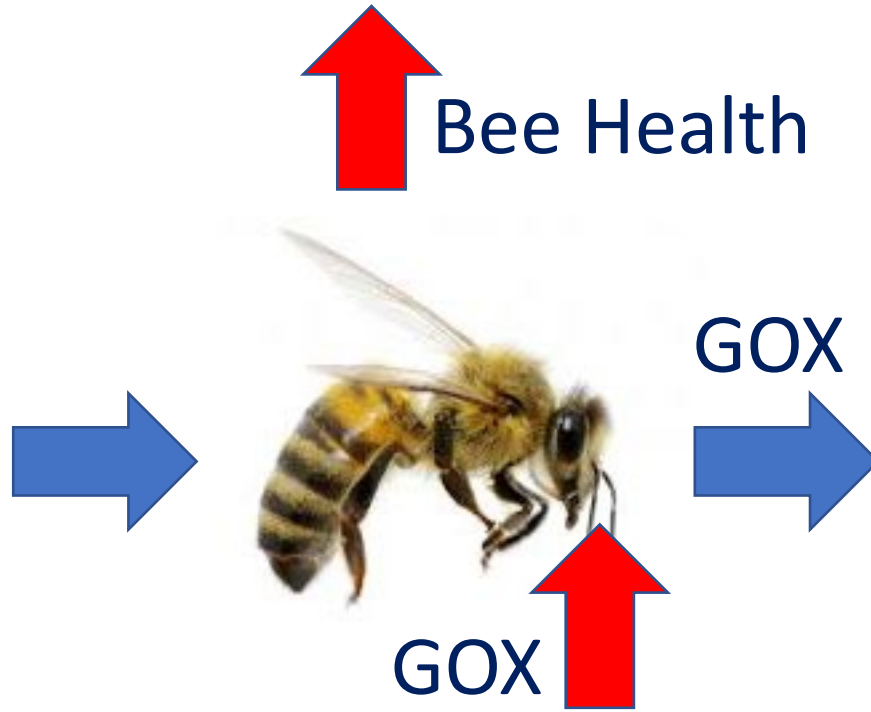
GOX



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Biodiverse floral resources



GOX

Bee Health

GOX



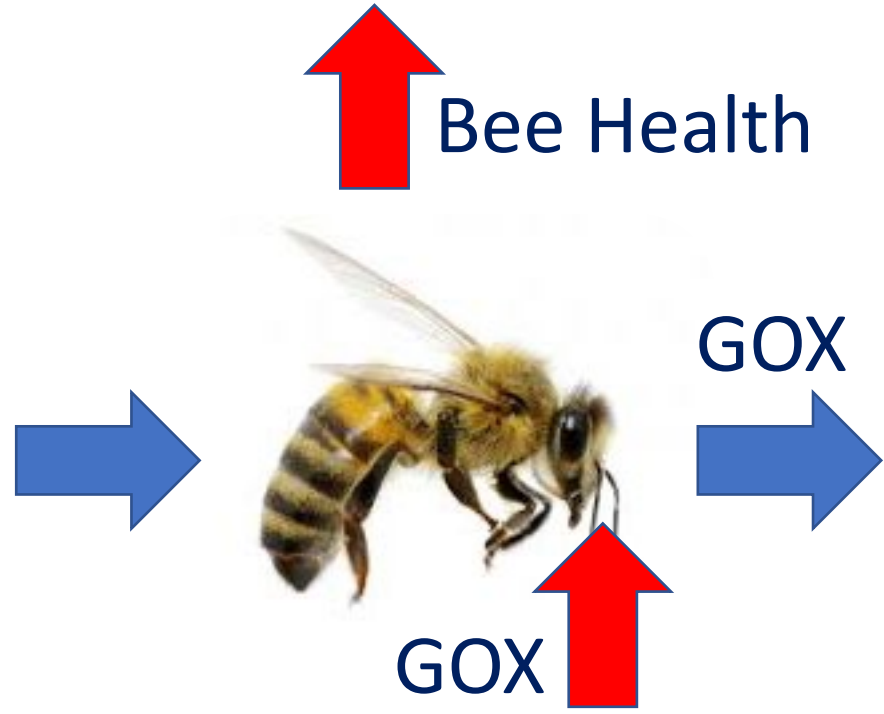
GOX



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Biodiverse floral resources



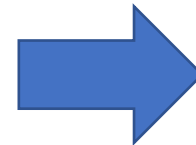
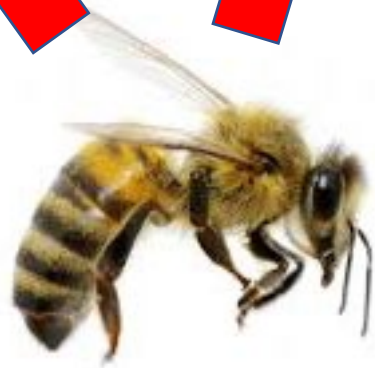
Bee Health



Enhancing forest and bee health for high-value medicinal honey: *Healthy forests – healthy bees – active honey*

Microbiome (bacteria/fungi):
Culture/16S/ITS

Flora/pollen:
ITS2



H_2O_2

GOX

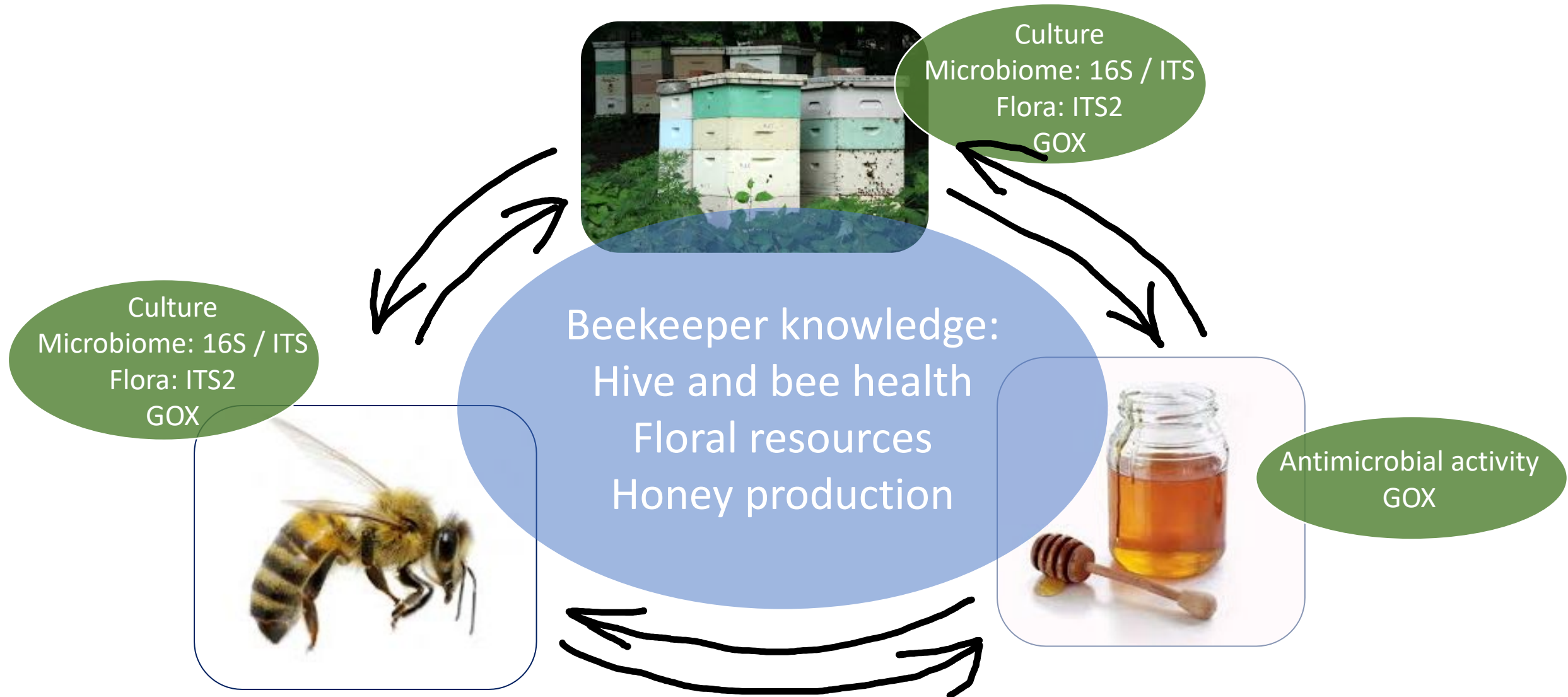
Flora/pollen:
ITS2

Chemistry

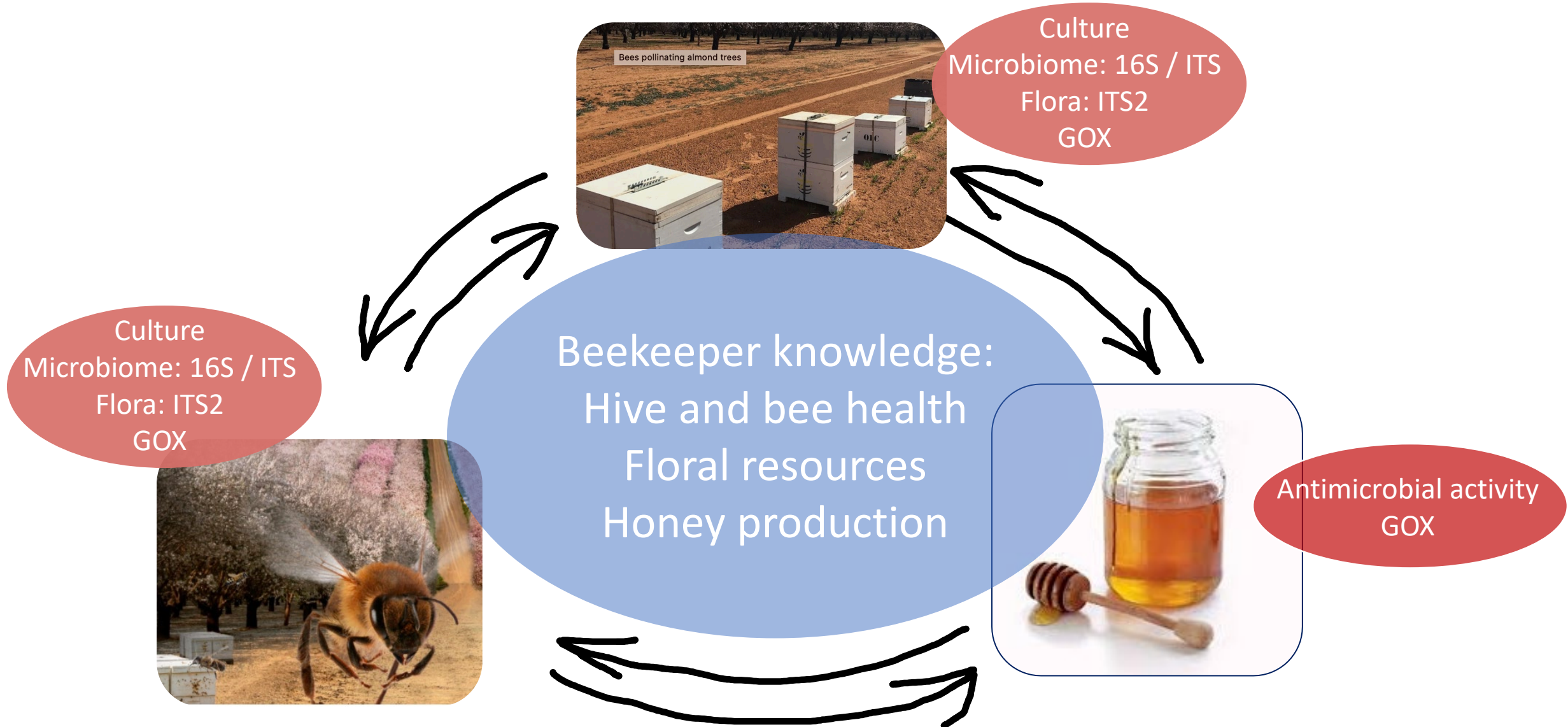
GOX

Antimicrobial activity

Enhancing forest and bee health for high-value medicinal honey: *Healthy forests – healthy bees – active honey*



Enhancing forest and bee health for high-value medicinal honey: *Healthy forests – healthy bees – active honey*





Questions?