material, but with totally different pore size distributions (Fig. 2). These results point to a strongly increased fragmentation during compression and explain the tremendous increase in binding capacity with increasing dehydration.

A comparative evaluation of the flow properties of the dehydrated product with other commonly used lactose products showed the former to be even better than the very good fluidity of sieved crystalline (100 mesh) α-lactose monohydrate. The flow properties were characterized by the flow through funnels of standard dimensions (Klein 1968), the Hausner ratio and the variation coefficient of the weight of 100 tablets (500 mg), by compression on a single punch tablet machine (Indola HOKO KJ) at 15 000 N compression force.

In conclusion, thermal dehydration or desiccation by means of organic solvents, like methanol, can convert crystals of α-lactose monohydrate into a stable anhydrous product with much increased binding capacity and excellent flowability.

REFERENCE

Klein, K. (1968) Oele, Fette, Wachse 94: 849

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Preliminary report on the antimicrobial activity of honey distillate

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Honey is used officially in pharmaceutical preparations as a sweetening and demulcent agent. Some Nigerian natives use it as an antitussive. It also has antimicrobial activity and has been suggested (World Health Forum 1981) for use in enhancing the healing of wounds and pressure sores and was reported in the Pharmaceutical Journal (1982) to be bactericidal to many Gram-positive and Gram-negative bacteria and *Candida albicans*.

Several mechanisms have been suggested to explain the antimicrobial activity. Sugar in honey being the cause of high osmotic pressure at the wound surface and the induction of an unfavourable low water activity thereby inhibiting microbial growth as well as the fermentation of the honey to produce alcohol in-situ have been suggested.

To exclude the possibility of the activity being due to the putative effect of sugar. This paper presents a preliminary report on the antimicrobial activity of honey distillate.

Materials and methods

Preparation of the honey distillates. Samples of locally obtained honey from different geographical zones in Nigeria, and imported honey for commercial consumption from England and West Germany, were purchased and destructively distilled under dry nitrogen, the distillates being obtained in fractions.

Organisms. The organisms and their properties are listed in Table 1.

Antibiotics and antimicrobial agents. Streptomycin (Glaxo Laboratories), nystatin suspension (Squibb & Sons Ltd.) and 5% w/v phenol as a laboratory reagent, were used.

Media. used were: Diagnostic Sensitivity Test agar (Oxoid) pH 7·4, Nutrient broth (Oxoid) pH 7·2, Sabouraud-glucose agar (Oxoid) pH 7·3, Sabouraud-glucose liquid media (Oxoid) pH 7·3.

Determination of minimum inhibitory concentration (MIC). 10^5–10^6 bacteria colony forming cells of overnight broth cultures, or 10^{-2} dilution in sterile 0·9% NaCl of the two-day fungal cultures, were spotted respectively on to a series of overdried D.S.T. or Sabouraud agar plates containing progressively increasing concentrations of the antimicrobial agents. The plates inoculated with bacteria were incubated at 37 °C while those with fungal organisms were incubated at 25 °C for about 48 h. The MIC of an antimicrobial agent was the lowest concentration inhibiting growth.

Antimicrobial assay. This was by measurement of zones of inhibition on agar plates seeded with appropriate organisms and incubated at 35 °C for 24 h.

Results and discussion

A yellowish-brown oil, easily solubilized in water, sugarless, b.p. 123–126 °C, pH 4·8, exhibited a broad spectrum antimicrobial activity to the test organisms (Table 2). Similar activity was produced by honey from all sources.

The MIC of the fraction was 0·5% v/v irrespective of the presence of chromosomal or R-plasmid-mediated resistance genes on the bacterial strains. At 0·5% v/v, the fraction was also fungicidal to *Candida albicans* and fungistatic to *Penicillium spp* and *Aspergilus niger*.

† Correspondence.

Table 1. Organisms used to evaluate the antimicrobial activity of the honey distillates.

Organisms	Relevant properties	Source and reference
Escherichia coli K-12 J53	Wild-type strain antibiotic susceptible	Prof. J. T. Smith. J. Antimicrob. Chemother. (1981) 7: 379–388
Escherichia coli K-12 J53 (R222)	R-plasmid mediate resistance to Sm, Ap, Tc, Su	Prof. J. T. Smith. J. Antimicrob. Chemother. (1981) 7: 379–388
Escherichia coli W667/(JR225)	R-plasmid mediated resistance to Gm, Ap, Tc, Cp, Ka, Nm	Dr A. J. Breeze. J. Appl. Microbiol (1981) 50: 469–474
E. coli K-12 J53(BN100)	R-plasmid mediated resistance to NT, Tp, Sm	Laboratory Stock
Proteus mirabilis	Resistant to Ap, Tc, Su, Sm, cfx, CM	Clinical isolate
Klebsiella aerogenes	Resistant to Tc, Ap, Su, Na	Clinical isolate
Pseudomonas aeruginosa	Resistant to Gm, Cb, Ap, Sm, Tp, Na	Clinical isolate
Coagulase-positive *Staph. aureus*	Cb, Fu, NT, Ap, Cm	Clinical isolate
Oxford *Staph. aureus*	Wild-type strain susceptibility	Laboratory stock
Serratia marcescens	Resistant to Ap, Tc, NT	Clinical isolates
Strept. faecalis	Resistant to Tc, Su	Clinical isolates
Bacillus subtilis	Su, Ap	Clinical isolates
Candida albicans		Clinical isolates
Penicillium spp.		Laboratory stock
Aspergilus niger		Laboratory stock

Sm, streptomycin; Gm, Gentamicin; Ka, kanamycin; Nm, neomycin; Ap, ampicillin, Tc, tetracycline; Su, sulphonamide; cfx, cefotaxime; Cm, chloramphenicol; Cb, carbenicillin; NT, nitrofurantoin; Na, Nalidixic acid.

Table 2. Zone of inhibition (mm) of the organisms by the test antimicrobial agents.

Organism	Honey distillase 0·5% v/v	Phenol 0·5% w/v	Streptomycin 2 μg ml^{-1}	Nystatin 30 units ml^{-1}
E. coli K12 J53	22	21	22	
E. coli K12 J53(R222)	22	20	Resistant	
E. coli W667(JR225)	24	23	25	
E. coli K12 J53(BN100)	23	22	Resistant	
Proteus mirabilis	24	23	Resistant	
Klebsiella aerogenes	25	24	25	
Ps. aeruginosa	28	18	Resistant	
Staph. aureus	29	26	27	
Oxford Staph. aureus	30	26	28	
Serratia marcescens	22	21	22	
Strept. faecalis	24	23	24	
Bacillus subtilis	28	8	29	
Candida albicans	26	10		17
Penicillium spp.	16	9		9
Aspergilus niger	10	8		10

The antimicrobial activity of this fraction was not pH dependent as judged by varying pH values using citric-acid/phosphate and phosphate buffered D.S.T. agar.

The distillate fraction, at 0·5% v/v, compared favourably with phenol 0·5% w/v, streptomycin 2 μg ml^{-1} and nystatin 30 units ml^{-1} against the organisms tested.

Exposure of a population of the organisms to varying dilutions of the fraction did not produce resistant mutants.

The broad spectrum antimicrobial activity of this distillate has thus been established and found not to arise as a result of any artefact that might originate from a specific geographical area.

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REFERENCES

The Pharmaceutical Journal (1982) May 1, p. 412
World Health Forum (1981) 2: 363